SCIENTIFIC AMERICAN SUPPLEMENT No. 184

Scientific American Supplement, Vol. VII., No. 184.
Scientific American, established 1845.

NEW YORK, JULY 12, 1879.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

CLASSIFICATION OF MOWERS AND REAPERS.

By ALFRED L. KENNEDY, M.D., President Polytechnic College, Philadelphia.

THE rapid multiplication of mowing and reaping machines, their various styles, and the number and complexity of their mechanical movements, annually increase the difficulty of justly comparing their respective merits. The difficulty is keenly felt by the inexperienced buyer, and it confounds the judges of rival claims at our agricultural fairs. It is intensified by the bold assertions and the voluminous "testimonials" of contending inventors and manufacturers, who, holding patents for trifling modifications, laud them as of vital importance. Societies seldom include on their rolls of members a sufficient number of "experts" able to decide upon the merits of competing machines. Absurdly contradictory awards are made every year, rendering manufacturers indifferent about exhibiting, lessening the public estimate of the value of the prizes, and encouraging unsuccessful competitors to urge the charge of favoritism.

Some kind of classification of these machines would seem to be absolutely necessary to assist purchasers and juries in making up their minds upon essential points of difference. To be of value, such classification should not be based upon minor characteristics, but rather upon those which distinguish the machine as a whole. Not, for example, on the width of cut, or the position of the cutting bar in the front or rear of the right drive wheel of the machine, but upon the systems by which the slow rotary motion of the wheels is converted into the rapid reciprocating motion of the connecting rod.

Such a system is technically termed "driving gear." By a careful examination of the principal machines in the market, the farmer perceives that they arrange themselves under a number of systems or types, differing from each other in the devices used to transmit power and change its direction. First, there are machines in which the reciprocating or to and fro motion of the connecting rod or pitman is produced by a crank pin, and second, there are others in which such motion is produced by a cam. The former division, comprising, as it does, nearly all the machines in use in this country, may be sub-divided into two very unequal groups, according to the means used to convert the rotary motion parallel with that of the drive wheel, into a rotary motion which is at right angles with the former and crosswise of the machine. There are three well-marked classes of machines in which this change of direction of the motion is effected by bevel gearing.

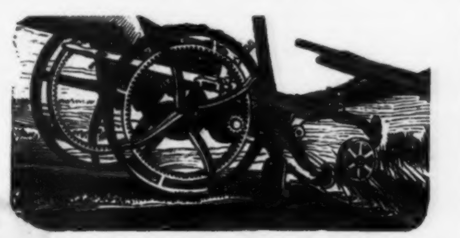


FIG. 1.—DRIVING GEAR OF "KIRBY" MOWER, ILLUSTRATING CLASS I, SUB-CLASS *a*.

CLASS I.

The first of these classes may with great propriety be constituted of all those machines which have a bevel wheel on the axis of a spur pinion of the driving gear.

SUB-CLASS *a*.—A familiar make of this class has the spur wheels attached to and made part of the drive wheels. So common is this form that it deserves to be erected into a sub-class. Each spur wheel, which is cast on what is to be the inside of the spokes of the drive wheel, operates a pinion, the axle of which usually extends across the machine to a corresponding pinion on the opposite side, operated in like manner. This axle, then the common axle of two pinions, carries a bevel wheel, the pinion of which operates a longitudinal crank shaft, the forward end of this carrying the crank pin, which drives the pitman. The enumeration in order of the members which compose the driving gear will render the peculiar feature of this sub-class quite apparent. The members are: 1, spur wheel; 2, pinion; 3, bevel wheel; 4, bevel pinion; 5, crank pin; 6, pitman.

SUB-CLASS *a*.—Has several varieties, some having the spur pinion in front of the axle of the drive wheels, of which the Kirby is a good example. (See Fig. 1.) Others have the spur pinion behind said axle.

SUB-CLASS *b*.—Another sub-divison of Class I. is composed of machines having the spur wheel on the axle of the drive wheels instead of on the wheels themselves, the whole gearing being central. The spur wheel engages a pinion on the axis of which is a second spur wheel. This drives a pinion carrying on its axle a bevel wheel. The axle of the pinion of this wheel, running, of course, lengthwise of the machine, at the front carries the crank pin, with pitman attached.

FIG. 2.—DRIVING GEAR OF THE NEW "WOOD" MOWER, ILLUSTRATING CLASS I., SUB-CLASS *b*.

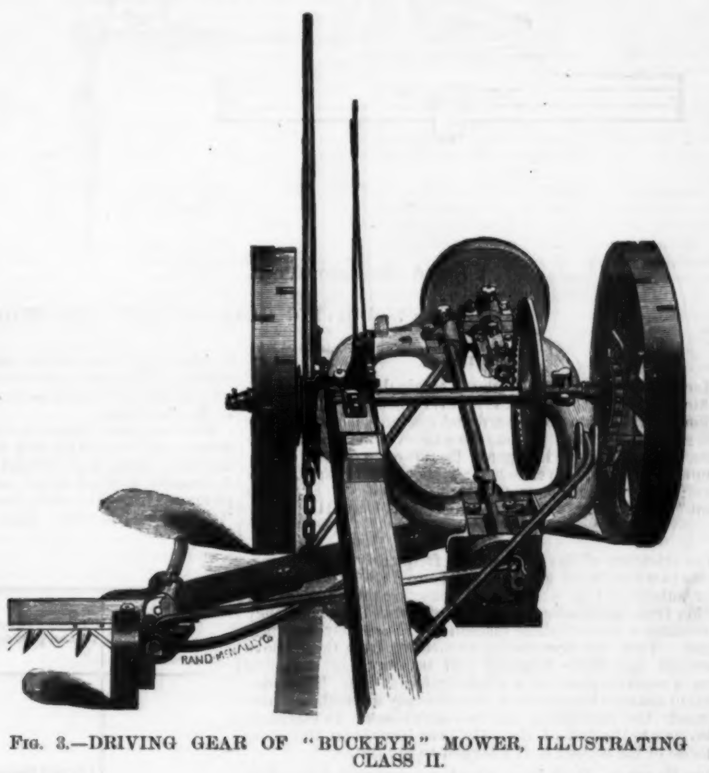


FIG. 3.—DRIVING GEAR OF "BUCKEYE" MOWER, ILLUSTRATING CLASS II.

The driving gear has more members than that of the preceding sub-class. They are: 1, spur wheel; 2, pinion; 3, spur wheel; 4, pinion; 5, bevel wheel; 6, bevel pinion; 7, crank pin; 8, pitman.

The Walter A. Wood new mower (see Fig. 2) is a good example of this sub-class.

CLASS II.

Machines belonging to this class have neither cog-wheels on the drive wheels nor spur wheel on the main axle, but this

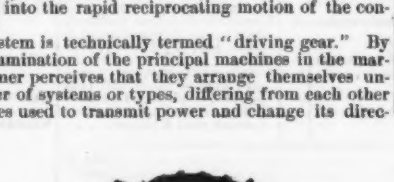


FIG. 4.—DRIVING GEAR OF "LITTLE GIANT" MOWER, ILLUSTRATING CLASS III.

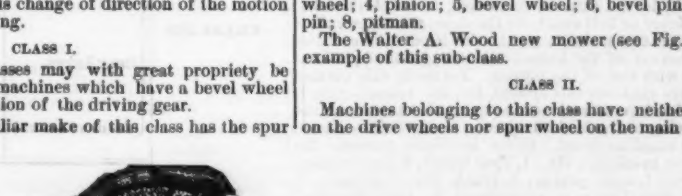


FIG. 5.—DRIVING GEAR OF "EUREKA" MOWER, ILLUSTRATING SUB-CLASS *a* OF CLASS IV.

axle carries a bevel wheel, the pinion of which operates a longitudinal shaft, carrying at the rear of the machine a spur wheel. This gives motion to a pinion, the shaft of which runs forward to the front of the body of the machine and carries the crank pin. The power is, therefore, transmitted by a series of six elements, viz.: 1, bevel wheel; 2, bevel pinion; 3, spur wheel; 4, pinion; 5, crank pin; 6, pitman. The bevel wheel on the main axle is the distinguishing feature of this class.

Class II. is represented by the "Buckeye" machine in its many varieties.

a rolling motion is given to it by the revolution of the convex toothed wheel, fixed on the main axle. The rocking, rolling motion of the concave wheel is controlled by the movement of an arm of the bent lever, which is firmly attached to it. This arm extends crosswise, nearly parallel with the main axle, until it reaches a crank pin on the end of a small, heavy, conical wheel, revolving on a mandrel projecting from the frame. The motion which the concave wheel imparts to this arm causes the crank pin wheel to revolve. These revolutions being maintained, give regularity to the swing of this arm of the bent lever, and, of course,

screw; 3, crank pin; 4, pitman; hence machines of this class can be at once identified. The fifth or tangent screw class finds its sole representative in the "screw" machine. The extreme simplicity of the driving gear renders illustration unnecessary.

CLASS VI.

In the above classes are comprised the machines most frequently found in the American market, but in foreign markets, and, to some extent, in ours, methods of converting the rotary motion of the drive wheels and their axles into

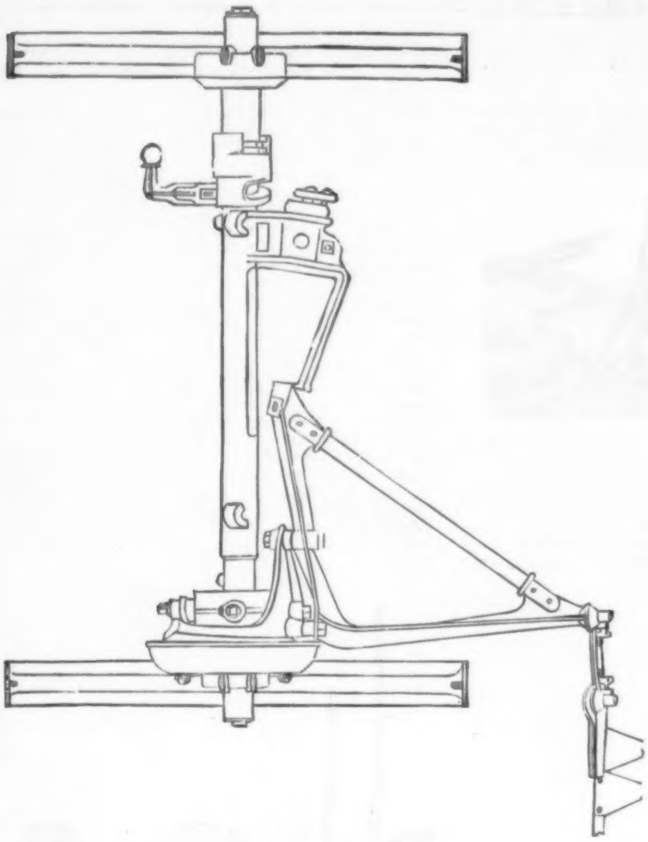


FIG. 6.—SKELETON VIEW.

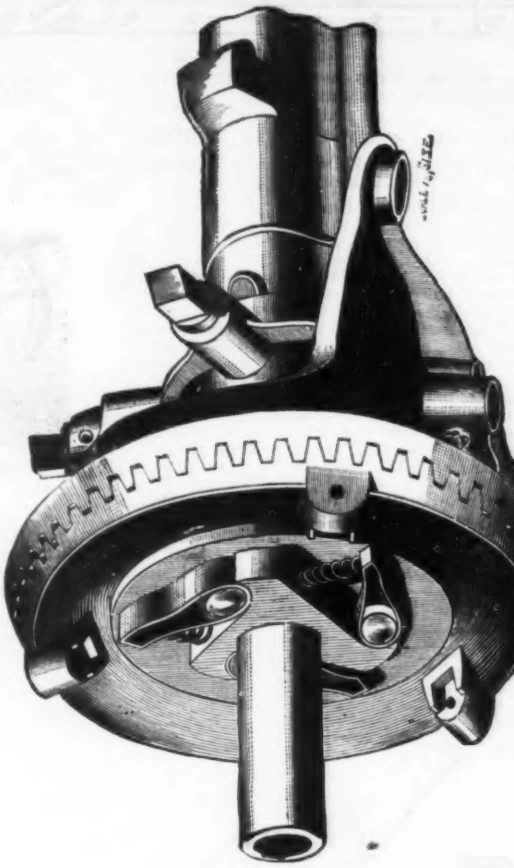


FIG. 7.

FIGS. 6 AND 7.—DRIVING GEAR OF NEW "CHAMPION" MOWER, ILLUSTRATING CLASS IV., SUB-CLASS *b*.

CLASS III.

Machines of this class have but a single drive wheel. Just within the rim of this wheel is a bevel wheel, the axle of the pinion of which runs backward and operates a spur wheel. This gives motion to a pinion, the axle of which carries the crank pin. The driving gear, therefore, consists of six members, viz.: 1, bevel wheel; 2, bevel pinion; 3, spur wheel; 4 spur pinion; 5, crank pin; 6, pitman. The "Little Giant" mower, Fig. 4, specially represents Class III.

CLASS IV.

The attention of the farmer is so frequently called to machines in which bevel gearing is dispensed with and the bent lever substituted as a means of changing the direction of motion from longitudinal to transverse, that the expediency of forming a class of these machines will scarcely be questioned. They are fortunately so distinct from those above described that little difficulty will be found in assigning them a separate place on a slight examination. Their distinction among themselves is also strongly marked, and may be made the foundation for two sub-classes. In machines belonging to the first of these the bent lever is on the shoe; in those of the second it is attached to the frame.

SUB-CLASS *a*.—Both drive wheels are cast with internal or concave spur wheels, operating two pinions on one shaft in rear of the main axle. The shaft carries a spur wheel which in turn drives a pinion, the axle of which carries the crank pin. This, the pitman, extending forward, connects with a bent lever or bell crank on the shoe, the other end of this lever being attached to a pin on the head of the cutter bar. The motion of the knives in cutting, therefore, is at right angles with that of the pitman. Formerly side cutting machines were made on this system, but the manufacture is now believed to be confined to those with direct draught, the cutter bar being in front of the driver, one of whose horses walks in the standing grass. Seven members transmit the power in these machines, viz.: 1, spur wheel; 2, spur pinion; 3, spur wheel; 4, spur pinion; 5, crank pin; 6, pitman; 7, bent lever. Sub-class *a* is represented by the "Eureka" mower, Fig. 5.

SUB-CLASS *b* OF CLASS IV.—There is but one machine in the market which has the bent lever that operates the pitman attached to the frame; but differs so widely from all others as to be worthy of the distinction of filling a subclass. Nor will it be easy for the reader, even with the aid of the well-executed cuts presented above, to get a clear conception of the construction, and especially of the mode of action of the parts. These consist of a small, convex, toothed wheel, closely resembling a bevel wheel, fitted on to the main axle, against the inside of the hub of the right wheel; a concave toothed wheel, of slightly larger diameter, its teeth of a size to fit into the spaces between those of the other, is attached by radial screws, passing through its prolonged hollow axle, to a collar, which, in like manner, is attached to a cylindrical portion of the iron frame of the machine, which encircles, like a sleeve, the main axle. The concave wheel is, therefore, held only by a "universal joint," and its proximity to the face of the convex wheel is such that, when the teeth on one of its edges are engaged, those on the opposite edge are freed. A rocking as well as

to the other arm, which extends forward at right angles with it. The transverse swing of the latter imparts, by a pitman and a ball and socket joint, a reciprocating motion to the cutter bar.

The bent lever forms, in fact, part of the concave toothed wheel, and rocks with that wheel on the "universal joint," and the driving gear consists of: 1, convex toothed wheel; 2, concave toothed wheel and bent lever; 3, crank pin; 4, pitman. Class IV., sub-class *b*, is represented by the new "Champion" mower. Figs. 6 and 7

reciprocating motion by means of cams are occasionally seen. This reciprocating motion has been obtained by constructing the drive wheel with a rib, running round inside the rim, its scalloped edge projecting toward the hub, more or less slightly at regular intervals, so as to give it a sinuous outline. To a nearly horizontal sliding bar a grooved roller is attached, its groove bearing against and partly embracing the sinuous projecting edge, the bar receiving therefrom a reciprocating motion as the machine is drawn forward. This construction finds no favor here, but a modification of it was

Mowers and Reapers—Schedule of Classification.

Reciprocating motion produced by	Change of direction of motion produced by	Location of Bevel Gearing.	Number of class.	Location of Main Spur Wheel and of Bent Lever.	Sub-classes.	Driving Gear consists of	Example.
CRANK PIN,	BEVEL GEARING,	Bevel wheel on spur pinion axle,	I,	Main spur wheel on drive wheel,	*a*,	1, Spur wheel; 2, spur pinion; 3, bevel wheel; 4, bevel pinion; 5, crank pin; 6, pitman, . . .	"KIRBY."
				Main spur wheel on main axle, .	*b*,	1, spur wheel; 2, spur pinion; 3, spur wheel; 4, spur pinion; 5, bevel wheel; 6, bevel pinion; 7, crank iron; 8, pitman, . . .	NEW "WOOD."
		Bevel wheel on main axle, . . .	II,	. . . .	. .	1, bevel wheel; 2, bevel pinion, 3, spur wheel; 4, spur pinion; 5, crank pin, 6, pitman, . . .	"BUCKEYE."
		Bevel wheel on drive wheel, . .	III	. . . .	. .	1, bevel wheel; 2, bevel pinion; 3, spur wheel; 4, spur pinion; 5, crank pin; 6, pitman, . . .	"LITTLE GIANT."
	BENT LEVER, . .	. . . .	IV,	Bent lever on shoe	*a*,	1, spur wheel; 2, spur pinion; 3, spur wheel; 4, spur pinion; 5, crank pin; 6, pitman; 7, bent lever, ...	"EUREKA."
				Bent lever on frame, ...	*b*,	1, convex toothed wheel; 2, concave toothed wheel and bent lever; 3, crank pin; 4, pitman,	NEW "CHAMPION."
	TANGENT SCREW,	. . . .	V,	. . . .	. .	1, worm wheel; 2, tangent screw; 3, crank pin; 4, pitman, . . .	"SCREW."
	Description.					No. of class.	
CAM, ...	The cams on the internal or external edge of cam wheel operating a grooved roller, revolving in head of pitman, ...					VI.	"WARDROP."
	The cams on the face of cam wheel operating its mate, which is connected with pitman, . . .					VII.	"GOODWIN."

Fig. 6 shows bent lever, crank pin wheel, and short pitman, the toothed wheels being boxed. Fig. 7 shows toothed wheels and "universal joint."

CLASS V.

The system of transmitting power directly from the drive wheels or their axle to the crank pin by the interposition of an endless or tangent screw differs entirely from all others, and may well be made the basis of a separate class. The tangent screw is operated directly by a worm wheel attached to the main axle. Both wheel and screw are cast of red metal, the latter is made two-threaded, is fitted to the frame of the machine, and is actuated by the lower margin of the rotating worm wheel. The axle of the tangent screw extends forward, and carries the crank pin, which drives the pitman. The driving gear consists of: 1, worm wheel; 2, tangent

to be seen in the Russian department of the Centennial Exhibition, having a spur wheel on the main axle. This operated a pinion, carrying on its axle a cam wheel, with the cams projecting from its convex surface. These gave reciprocating motion to a sliding bar in a manner similar to that just described, and thence to the pitman.

CLASS VII.

An exceedingly ingenious application of the cam movement to mowers has been made in this country by casting the projections upon the face of a small wheel in the form of radial ribs. Rapid motion is given to this ribbed wheel by putting it upon the axis of a pinion driven by a spur wheel on the main axle. A similarly ribbed wheel, the ridges of which fit exactly into the furrows of its mate, is so fitted as, when in that position, not to rotate with it, but to slide

to and from it at right angles with the plane of rotation. Thus by the sliding of the ribs on the face of one wheel up and down the sides of the ribs on the face of its opposing mate, reciprocating motion across the machine is obtained and imparted to the pitman.

Class VII. is represented by Goodwin's machine.

To group the above classes under a few heads, to arrange them in the form of a schedule on a single sheet, is simply to imitate the convenient methods pursued in the study of natural history. The preceding schedule has been prepared with this view. Taking as its basis that movement common to mowers and reapers, whereby rotary motion is converted into reciprocating, it groups them under two divisions, and the divisions are characterized, one by the crank pin, the other by the cam. Machines of the former division are further classified according to the means used to obtain transverse motion, whether by bevel gearing, bent lever, or tangent screw; those of the latter division according to the position of the cams, whether on the edge of the cam wheel or on its face.

ORNAMENTAL PLANTING.

AT a late meeting of the Scottish Horticultural Association, Mr. C. S. France, of Penicuick, replying to the question, "What should be the first object of the landscape gardener?" said, It is to give an appearance of extent to a limited space by the proper distribution of shrubs and clumps of plantation. How can this be attained? First, by distributing your clumps in such an irregular manner that the views, either looking from the mansion or entering upon the grounds, will be intercepted by these clumps, and preclude the possibility of seeing at a glance the full extent of the ground. Again, one object which ought ever to be borne in mind is that where it is necessary to inclose your ground by either a wall or an unsightly fence, this should as soon as possible be masked by some low planting of shrubs or low-growing trees; and if the surrounding country or neighboring possessions are of a suitable nature, you can then take possession of the view outside of your own ground, and thereby give or convey to the observers the idea of greater extent. This principle, although given in reference to a residence with a small area of ground attached, is still quite as applicable to grounds of larger extent; and, while in some cases this may be varied to suit particular circumstances, I consider it the basis upon which ornamental planting should be carried out.

SOWING OATS AND WHEAT TOGETHER.

THE experiment has been tried in Iowa of sowing in the fall, upon one acre of land, two bushels of wheat mixed with one bushel of oats. The oats shot up rapidly, and were of course killed down by the frost. But they furnished a warm covering for the earth, and when the snow fell among the thick stalks and leaves they kept it from blowing away. This covering prevented the winter-killing of the wheat, and the rotting oat leaves and stalks afforded a rich top-dressing for the crop the following spring. The result was an abundant yield of wheat, while land precisely similar alongside of it, and treated in the same manner, with the exception of omitting the oats, was utterly worthless.

SOCRATES ON AGRICULTURE.

SOCRATES is reported to have said: "Agriculture is an employment the most worthy the application of man, the most ancient, and the most suitable to his nature. It is the common nurse of persons in every age and condition in life; it is the source of health, strength, plenty, and riches, and of a thousand sober delights and honest pleasures. It is the mistress and school of sobriety, temperance, justice, religion, and, in short, of all virtues."

TEMPERATURE OF SOILS

By PROF. E. WOLLNY.

IN summer and in warm weather compact soils are on the average warmer than loose ones, but in winter, and on a fall of temperature in summer, they are colder. In warm weather compact soils are warmer by day and colder by night than loose ones, and are subject to greater fluctuations of temperature.

ARTIFICIAL HORSE DUNG.

By PROF. MAYER.

A MANURE is said to be exported from England to Holland which has the outward appearance of stable manure, but on examination proved to be a mixture of straw and decayed leaves.

SHEA BUTTER.*

By E. M. HOLMES, F.L.S., Curator of the Museum of the Pharmaceutical Society.

THE attention of commercial men is now being directed more and more every year towards Africa, and the products of that country will probably be gradually turned to account as new uses are found for them. Among these shea, or galam, butter seems to me to deserve some degree of attention. This substance is a solid fat obtained from the seeds of *Butyrospermum Parkii*, and forms an important article of commerce in Western Africa. Mungo Park, in his "Travels," p. 202, gives the following account of it: "We passed a large town called Kabba, situated in the midst of a beautiful and highly cultivated country, bearing a greater resemblance to the center of England than to what I should have supposed had been the middle of Africa. The people were everywhere employed in collecting the fruit of the Shea trees, from which they prepare the vegetable butter, mentioned in former parts of this work. These trees grow in great abundance all over this part of Bambarra. They are not planted by the natives, but are found growing naturally in the woods; and, in clearing wood land for cultivation, every tree is cut down but the shea. The tree itself very much resembles the American oak; and the fruit, from the kernel of which, being first dried in the sun, the butter is prepared by boiling the kernel in water, has somewhat the appearance of a Spanish olive. The kernel is enveloped in a sweet pulp, under a thin green rind; and the butter produced from it, besides the advantage of keeping the whole year without salt, is whiter, firmer, and to my palate of a richer flavor than the best butter I ever tasted made from cow's milk. The growth and preparation of this commodity seem to be among the first objects of African industry in this and the neighboring states, and it constitutes a main article of their inland commerce."

On p. 352, Park gives a rough figure of the leaves and seed of the tree, which is described by Oliver as attaining a height of 30 or 40 feet, with a trunk 10 feet high and 5 or 6 feet in circumference, branching like an oak and yielding on incision a copious milky juice. The branches present a somewhat bare appearance on account of the leaves being crowded together at the tips of the branches. The leaves are large and handsome, with wavy edges and parallel ribs.

By Captain Grant (who saw the tree during the Speke and Grant expedition) the wood is stated to be red like cedar and very hard and close grained, so much so that the natives think it unfit to be cut by their hatchets. The milk, which exudes when the bark is cut, becomes when dry a hard white insoluble gum. He states that the flowers, which are produced in December, are of a creamy yellow, and occur in thick clusters at the end of the branches; they smell strongly of honey and are much frequented by honey bees; they soon fall off and cover the ground. The bark of the tree when growing near villages is frequently much chipped off, it is supposed for medicinal purposes.

The fruit is about the size of a pigeon's egg and is ripe in May and June. It has the appearance and somewhat the structure of an olive, having an external fleshy portion which when ripe is said to resemble in flavor an over-ripe pear, and being very sweet is eaten by the natives. The endocarps, after removal of the fleshy portion, are dried in the sun and are then easily broken. After removal of the shells the kernels are bruised and boiled in water, and the fat which floats on the surface is skimmed off and collected for use.

The tree was first discovered by Mungo Park in the kingdom of Bambarra, but has since been found abundantly in the Niger country and also in the Nile land, Niammiam country, Madi, and at Bornou in Central Africa. Further south, in the Gaboon and neighboring countries, two other species, *Bassia Djave* and *B. Nounjou*, yield a somewhat similar fat.

A specimen of shea butter was exhibited at the International Exhibition in 1851, by Dr. J. O. McWilliam, from Egga, on the Niger. A portion of this specimen is still in the Hanbury collection in the museum of this society.

In the year 1867, 7·7 hundredweights of this substance were imported, valued at £1,553. At the present time the quantity imported into this country varies from 300 to 500 tons, but larger quantities of it than of palm oil could easily be obtained. It is imported in casks containing from 10 to 15 hundredweights, and has been sold in this country at prices varying from £36 to £40 per ton. The exact quantity, however, which reaches this country is difficult to ascertain, for Mr. Shaw, of Liverpool, informs me that at Liverpool, to which port all that is imported is believed to come, it is not always distinguished from palm oil, and in fact often passes under that name.

Both in this country and in Belgium it appears to have come into use during the last twenty years in soap making, and specimens of products obtained from it were exhibited at the International Exhibition at Paris, last year.

In soap making it is chiefly used to add to cheap soaps to prevent their washing away too rapidly, as it seems to harden them.

Mr. W. Henderson, of Glasgow, to whom I am indebted for specimens of shea butter, says of it: "Of all the fats with which I am acquainted, shea butter seems to remain unaltered longest, and although it comes from a warm country, and is treated in a way to induce it to become rancid, there is not the slightest rancidity in any samples I have seen; while palm oil, which comes from the same country, is in a very rancid and decomposed state. It could easily be purified by boiling once or twice in water containing a small quantity of bitartrate of potash, and the mixture made of the density of 10° or 15° Twaddell, by the addition of salt, the melted fat being allowed some time to settle. The remarkable keeping property of this substance seems to indicate that it might be used with advantage as a basis for ointments and suppositories, and even perhaps for some plasters, such as empl. cantharidis, with advantage. Mr. Henderson has also kindly presented the museum with specimens of a peculiar substance which he calls gutta shea, and states is present in the butter to the extent of one-half per cent only. He thinks this substance should be removed if the butter be used for candle making, since it burns with a very smoky flame. It can be removed from the fat by dissolving it in a mixture of three parts of ether and one of alcohol, when it separates in a filmy state, but more readily if the fat be saponified. The gutta shea is a hydrocarbon, soluble in oils and fats, and in strong nitric acid with oxidation and the deposit of a little flocculent matter, but is insoluble in sulphuric and muriatic acid and alkalies.

Gutta shea burns readily, giving off a large quantity of smoke, and leaving about 0·25 per cent. of ash. It can be easily separated from soap containing only one part of the gutta in 2,500. This substance as yet does not appear to have received any practical application, but deserves investigation.

In some respects it seems to resemble the balata or chicle gum obtained from an allied tree, *Achras sapota*, L., belonging to the same natural order (Sapotaceæ), but growing in British Guiana. Gutta shea, however, presents more of a waxy consistence and appearance. It has scarcely any taste, and softens without melting when chewed.

At common temperatures shea butter is a dirty white solid, but when freshly prepared it is said to have a grayish or greenish white tint. Analyzed by Oudemans it was found to yield about 70 per cent. of stearic acid and 30 of oleic acid, but no palmitic acid. Pfaff also confirms this statement. The butter is said to soften at 95° F. and to melt at 109° F., but the melting points both of the butter and the fatty acid obtained from it have been differently stated by different authors.*

The stearic acid is stated by other writers to be unsuited in the pure state for candle making, since it contracts too much in cooling and does not present a translucent or polished appearance, but that it answers well when mixed with other fatty acids, such as palmitic.

Mr. W. L. Carpenter, chemist to Messrs. Thomas' soap works, at Bristol, tells me that shea butter may be obtained nearly white by repeated filtration in a warm closet. He believes there are two sorts of shea butter, varying in their percentage of stearic acid, since the melting points of the two differ by about 4° C. Whether this peculiarity be due to its occasional admixture with palm oil or whether the butter be collected from more than one species of bassia tree must remain for the present an open question. My object in bringing these notes before you has been rather to elicit suggestions as to the possible practical application in pharmacy of a hitherto unused waste material, and of a fat which presents the advantage of not becoming rancid for a considerable length of time, than to contribute any new information.

* Read at an Evening Meeting of the Pharmaceutical Society of Great Britain, April 2, 1879.

* See *Dingler's Polytechnische Journal*, Jan., 1878, p. 168.

ABSORPTION OF SELENIUM BY PLANTS.*

By CHARLES A. CAMERON, M.D., Professor of Chemistry and Hygiene, R.C.S.I.

THE subject of the possibility of replacing some of the elements found in plants by other elements of the same atomicity has not engaged the attention of British chemists; but on the Continent a few attempts in this direction have been made, generally with but little success. For example, Berner and Lucanus vainly attempted to replace ferric oxide (Fe_2O_3) in plants by the manganese analogue of that compound (M_2O_3). Experiments made with the view of substituting sodium for potassium in plants have invariably given negative results. The possibility of completely replacing an element in plants by another was, however, proved by me in a paper read before this society in 1868. I found that rubidium was capable of taking the place of potassium. It may be that certain bodies, though not capable of completely replacing other substances in vegetables, may be partially substituted therefor. The varying proportions of sodium and potassium found in the ashes of plants would seem to indicate such a partial replacement. As a rule, whenever potassium is sparsely present in the ashes of a plant, sodium abounds therein, and *vice versa*.

The analogy between sulphur and selenium suggests the possibility of the latter wholly or partly replacing the former as a constituent of vegetables. Sulphur exists in plants on two conditions, namely, as a constituent of sulphuric acid, and as an ingredient of albuminous and certain oily bodies. Sulphur is only taken up into the mechanism of plants in the form of sulphates, such as, for example, calcium and sodium sulphates. By the partial deoxidation of these sulphates, sulphur is procured by the plant and employed in the elaboration of its albumen, casein, and other albuminoids. The results of the interesting experiments of Arendt render it both probable that sulphur is both oxidized and deoxidized in the plant at different periods of its development. Thus, after blossoming the oat was found to contain more sulphur trioxide than before the ears of the plant had formed; and whilst the sulphur trioxide disappeared altogether from the lower part of the stem, it increased largely in the leaves and in the plant at large.

Now, there are two problems to be solved in relation to the substitution of selenium for sulphur in plants. First, can selenium in the form of selenic acid replace sulphuric acid? Second, can selenium replace sulphur as a constituent of albuminous bodies? If it were possible through the agency of the organs of plants to effect the replacement of an element not merely in an organic, but in an organized body, the achievement would be one of the greatest importance. Absolutely nothing has been done in the way of effecting the synthesis of new bodies by means of the wonderful combining powers which are exerted in the vegetable mechanism.

The difficulty with which compounds of selenium analogous to the organic bodies containing sulphur are prepared, and the instability of so many of them, are facts which deter one from feeling sanguine as to the possibility of effecting the synthesis of organized selenium bodies by means of plants; still the attempt is worth making. Much more hopeful is the chance of replacing sulphuric acid by selenic acid. I am of this opinion from the results of an experiment which I made several years ago upon a very small scale, and which I never published up to the present, every year intending to repeat it upon a larger scale. The experiment was as follows: A sod was taken from a field in which a crop of the so-called artificial grasses (which are chiefly leguminous plants, and not grasses at all) was just peeping over ground. The sod was 2 feet in depth, 3 feet in length, and 1 foot wide. It was placed in a box, and one-half of the plants were watered twice a week with a weak solution of potassium selenate (K_2SeO_4). During four weeks the total quantity of potassium selenate applied to the plants amounted to 20 grms., which comprised my whole stock of the article.

Now, this experiment was merely a tentative one. First, to ascertain whether or not selenic acid would act injuriously upon plants. Secondly, to discover whether or not the selenic acid could partly replace the sulphuric acid, or rather could be taken up into and permanently retained by the plant. With respect to the action of the selenate, I could not perceive any difference between the plants to which the salt had been applied and those to which it had not. I came to the conclusion, therefore, that selenic acid applied at least in small quantities did not injure plants.

The next step was to ascertain whether or not the selenic acid had been partially absorbed. The plants were accordingly partially dried, and boiled in strong nitric acid until thoroughly destroyed. The solution was evaporated to dryness, and the residue was treated with dilute hydrochloric acid, which dissolved it nearly completely. The solution was concentrated and mixed with a saturated solution of sulphurous acid, whereupon the liquid assumed at once a deep blood-red color, from the separation of selenium.

Before the plants were partially dried they were carefully washed, in order to separate any traces of selenate which might have adhered to their surface. The application of the selenate solution was discontinued for a fortnight before the plants were taken up.

I think this experiment proves that selenic acid is not injurious to plants when used in small quantity, and that the acid is taken up and retained by plants, or at least of certain varieties of plants. The experiment, however, did not prove whether or not there was a partial replacement of sulphur trioxide by selenium trioxide or of sulphur by selenium. Having lately become possessed of large quantities of selenium compounds, I proposed to grow plants in soil or water free from sulphur in any form, but supplied with potassium and ammonia selenates. Should the results of this proposed experiment prove interesting, I shall do myself the honor of submitting them to the society.—*Chemical News.*

COMPOSITION OF THE MILK OF COWS OF DIFFERENT BREEDS.

By E. MARCHAND.

THE author finds free lactic acid, a constituent hitherto invariably overlooked, present to the average amount of 2 grms. per liter. The relative proportions of albumen and casein fluctuate much, but their joint weight is little affected. If the cow has eaten cruciferous plants the milk is rendered poor in casein and rich in albumen, thus effecting the production of cheese.

* Paper read before the Royal Dublin Society, May 19, 1879.

[Nature.]

THERMO-CHEMICAL INVESTIGATION.

The introduction of a new method of research, or the invention of a new instrument, has repeatedly marked an epoch in the development of more than one branch of natural science. The last few years have witnessed the introduction into chemical research of a new method of examining chemical changes, a method which is founded upon the study of those thermal reactions which accompany these changes.

The older methods of chemical investigation failed to throw any definite light upon many important problems, some at least of which have been brought a step nearer complete solution by the application of the newer method of thermo-chemical measurement.

When solutions of two salts are mixed, the products of the mutual action of which salts remain in solution under the experimental conditions, it is frequently found impossible to determine, by means of the ordinary analytical processes, the chemical distribution of the mass of reacting matter at the expiry of the experiment.

Again, there are certain acids which undoubtedly form two series of well-marked salts, but which appear to be capable, under certain ill-defined conditions, of forming a third series of unstable saline derivatives. How to determine the basicity of such acids has long been one of the unsolved problems of chemistry.

Once more, the ordinary methods of investigation have failed to supply us with any far-reaching generalization concerning the stabilities of series of compounds. Certain relations have undoubtedly been traced between general chemical properties of compounds, the properties of their constituent elements, and the stability of these compounds, but, nevertheless, the shadowing forth of well-marked generalizations, connecting stability of compounds with chemical structure, from which generalizations exact deductions, capable of experimental investigation, might be made, dates from the introduction of the thermo-chemical method of investigation.

That system of notation which is now employed in chemistry, although of the greatest value, is nevertheless far from being perfect; it fails to tell anything concerning the changes in forms of energy involved in those changes of distribution of mass which it formulates. Previous to the introduction of the thermo-chemical method little or no exact knowledge regarding these changes of energy was in the possession of chemists.

Chemists were long aware that certain reactions were possible only under stated conditions of temperature, pressure, etc., but until measurements had been made of the amounts of heat evolved or absorbed in these reactions they were unable to generalize the connection between the conditions of the reactions and the possibility of their occurrence.

Such are some of the problems which have been at least partially solved by the new method.

The fundamental position of thermal chemistry may be thus stated: "Every chemical change taking place without the aid of extraneous forces tends to produce that body, or system, in the formation of which the greatest evolution of heat occurs."

As a deduction from this statement, Berthelot formulates his law of maximum work as follows: "That salt, the formation of which is attended with the greatest evolution of heat, is always produced when those salts, from whose mutual action it may be formed, exist in solution in a condition of partial decomposition."

Many special instances illustrative of these generalizations might be cited; let one or two suffice. Chlorine decomposes dry sulphureted hydrogen with formation of hydrochloric acid and separation of sulphur; iodine does not decompose sulphureted hydrogen under the same conditions. The formation of hydrochloric acid and sulphur in the first change is accompanied with the evolution of a considerable quantity of heat; the formation of hydriodic acid and sulphur, in the second case, would involve the absorption of much heat. If, however, the action of extraneous forces be allowed to supervene, a new condition of equilibrium is attained; add water to sulphureted hydrogen and iodine, hydriodic acid and sulphur are produced. But the solution in water of hydriodic acid, which is the potential product of the reaction, involves the evolution of more heat than is absorbed in the reaction itself.

Iodine scarcely decomposes water, but if sulphurous acid be added to water, iodine is capable of bringing about decomposition, the products of the reaction being hydriodic and sulphuric acids

$$(H_2O + I_2 + H_2SO_3 = H_2SO_4 + 2HI).$$

Now it is found that the formation of sulphuric from sulphurous acid is accompanied with the evolution of a considerable amount of heat, if, then, the decomposition formulated $2H_2O + 2I_2 = 4HI + O_2$ be started, the combination of the oxygen thus produced with the sulphurous acid present, causes the evolution of more heat than would be evolved in any other series of chemical changes which could occur among the bodies present.

The applications of the thermal method in general chemistry are many and important. I propose briefly to consider some of the results obtained by this method, as shown in the phenomena attending the neutralization of acids; in the changes which occur on mixing solutions of two salts which are capable of undergoing decomposition with the production of salts themselves soluble under the conditions of experiment; in the measurements of (so-called) affinities between elementary bodies; and in one or two other reactions of general interest.

The neutralization of an acid by an alkali is attended with the evolution of a constant amount of heat; in some cases it is noticed that the total amount of heat evolved is independent of the relative quantities of acid and alkali employed, while in other cases the total heat evolution may be divided into two equal portions, one-half of the whole accompanying the addition of the first portion, and one-half accompanying the addition of the second portion of alkali. Those results evidently point to the exhaustion of the available energy of the acid (or alkali) as a phenomenon which takes place in regular stages. The thermal results of neutralization phenomena are rendered more intelligible when we find that an acid, the neutralization of which is accompanied with the evolution of but one quantity of heat, is also a monobasic acid; while in the case of a dibasic acid the total amount of heat evolved on neutralization with alkali is divisible into two distinct portions. Further, a difference is traceable between the thermal phenomena which attend the neutralization of an acid by caustic potash or soda, on the one hand, and by ammonia on the other.

The reaction formulated

$$2KHO + H_2SO_4 = K_2SO_4 + 2H_2O,$$

involves the expenditure of 31,000 thermal units; but the reaction $2NH3 + H_2SO_4 = (NH_4)_2SO_4$ is attended with the expenditure of but 28,150 thermal units.

If, however, a compound more strictly comparable with caustic potash in its chemical structure be employed to neutralize sulphuric acid, we find that the heat evolved is equal in both cases; the reaction

$$2N(CH_3)_4OH + H_2SO_4 = (N(CH_3)_4)_2SO_4 + 2H_2O,$$

is attended with the evolution of 31,300 thermal units.

From the point of view of their thermal reactions, the alkalies (including thallium hydroxide) and the alkaline earths are strictly equivalent, so far as the power of neutralizing one and the same amount of sulphuric acid is concerned.

The effect of substituting various compound radicles for the hydrogen of ammonia is well shown in the phenomena attending the neutralization of acid by ammonia, and by those substituted products. The introduction of a C_nH_{2n+1} group (C_2H_5, CH_3, etc.) into the ammonia molecule produces a substituted ammonia, the heat of neutralization of which is the same as that of the parent body; but if a negative radicle (such as C_6H_5) be substituted for hydrogen, then a compound is produced in the neutralization of which less heat is evolved than in the neutralization of the parent body. Thus the neutralization of hydrochloric acid by ammonia is accompanied with the evolution of 24,540 units of heat, while the neutralization of the same acid by aniline ($NH_2C_6H_5$) is accompanied with the evolution of only 15,000 to 16,000 thermal units.

When solutions of two salts are mixed under conditions such that the products of their mutual action remain in solution, thermal measurements throw very considerable light on the progress of the chemical change.

The problem presented by the phenomenon now under consideration is one of those which are peculiarly difficult of attack by the older methods. If a third body were introduced into the mixture of salts, which should combine with, or render insoluble, one or more of the possible products of the action, a new configuration would be initiated, new chemical changes would probably occur, and we should be unable to say whether the results obtained were really trustworthy representations of the action which had taken place between the members of the original system.

But measurement of thermal changes involves no disturbance of the equilibrium of the reacting chemical system, and at the same time it yields trustworthy information regarding the changes which have occurred in the distribution of the mass of matter comprising that system. To take an example: On adding a solution of potassium chloride to dilute hydrochloric acid no thermal change is noticed; on adding a solution of potassium sulphate to dilute sulphuric acid heat is absorbed, the amount of heat so absorbed increasing with the amount of acid added, until a limiting point is reached. If the solution of potassium sulphate be made more and more dilute, less and less heat is absorbed. Now these facts evidently point to the occurrence of two processes of chemical change in the above reaction, viz., the direct action, formulated $H_2SO_4 + K_2SO_4 = 2KHSO_4$; and the inverse action, formulated

$$2KHSO_4 + H_2O = K_2SO_4 + H_2SO_4 + xH_2O.$$

We are thus taught to regard this chemical change as dependent on the conditions of the experiment, and further we obtain a glimpse of the decompositions and recompositions which are continuously occurring among the molecules of our seemingly stable compounds.

If solutions of zinc acetate and sodium sulphate be mixed no thermal change is noticeable; but if solutions of zinc sulphate and sodium acetate be mixed, an evolution of heat occurs, that is to say, a chemical change (or a series of chemical changes) proceeds. Such an experiment as this, besides throwing light upon the special chemical change under consideration, leads to a clearer conception of those phrases "strong acid," "weak base," than was generally to be found before the introduction of the thermal method into chemistry. A strong acid is evidently an acid in the formation of the salts of which much heat is evolved, and a weak acid is one in the formation of whose salts little heat is evolved, or heat is absorbed. If, therefore, the heats of neutralization of two acids by given bases be known it may become possible to predict what chemical changes will occur when given salts of those acids are mixed.

Attempts have been made from time to time to measure the so-called affinities of the elementary atoms. These attempts have been considerably advanced, and the whole problem of affinity has been much defined by applying the results of thermal measurements to chemical reactions.

If chlorine be mixed with hydrogen, and the mixture be exposed to daylight, hydrochloric acid is produced with evolution of a large amount of heat; the formation of hydrobromic acid from its elements is accompanied with the development of less heat, while heat is absorbed in the formation of hydriodic acid from its elements. These thermal reactions show that more energy changes form in the first than in the second, and more in the second than in the third of these reactions. The amount of energy of motion which is convertible into thermal energy, under fixed conditions, seems, therefore, to measure the mutual affinities of chemical elements.

But we do not know what is the amount of energy spent in decomposing the molecules of hydrogen and chlorine; the heat developed in the reaction

$$2H + 2Cl = 2HCl$$

is, therefore, the sum of the plus and minus thermal changes during the cycle of chemical changes, the initial and final stages of which are chlorine and hydrogen molecules and hydrochloric acid molecules respectively. Therefore it is evident that thermal measurements do not give data which suffice for determining the absolute affinities of the elements.

If the elements comprised in a natural group be converted into similar compounds—say into oxides—and if that element in the formation of whose oxide the greatest amount of heat is developed be said to have the greatest affinity for oxygen, many remarkable relations may be shown to exist between the affinities and the atomic weights of the elements in such a series. Thus Thomsen has shown that in the group comprising magnesium, calcium, strontium, barium, the affinity for chlorine, bromine, and iodine increases with increase of atomic weight, while the affinity of the haloid compounds of these elements for water decreases as the atomic weight of the elements increases. Many more exceedingly interesting results are brought out by Thomsen in the same paper.

The results of thermo-chemical investigation—a few of which I have endeavored to sketch in thinnest outline—suggest one or two considerations regarding chemical action in general, and regarding some of those problems which yet remain to be solved by chemical science.

The older theory of chemical action is based upon the idea that the reacting bodies exert force upon one another; the word affinity has thus a positive meaning.

Recently the view has gained ground, with some chemists, that a chemical change is but the outward representation of a loss of energy occurring within the reacting system; that no positive force is exerted between the reacting molecules, but that the system, as it were, falls to pieces because the conditions are realized under which a loss of energy is possible.

The latter view, I think, fails to account for the facts; there is no doubt that it expresses a truth, but surely only a partial truth.

General considerations, no less than those derived from thermal measurements, compel us to regard the first action between two elementary molecules as consisting in a decomposition of those molecules with the production of their constituent atoms, which afterwards combine with the formation of new molecules. But the decomposition of elementary molecules involves the expenditure of energy; in other words, there is a mutual action and reaction between these molecules. If this stress be regarded from the point of view of one set of the reacting molecules only, we certainly have positive force exerted.

It is not a mere negative loss of energy, but a positive action of one kind of molecules upon another kind of molecules; and the amount of force exerted is different for different elementary molecules. Hence chemical affinity is a positive force. The mutual action and reaction between the molecular systems involves the loss (or gain) of energy, but this loss of energy does not furnish a complete account of the action.

Thermal measurements enable us to determine the quantity of energy entering or leaving a given chemical system during its passage from one state to another. These measurements, therefore, give us most valuable information concerning the phenomena exhibited by those chemical systems.

The results obtained by these measurements show how great is our ignorance with regard to the progress of chemical reactions in general; and they suggest many exceedingly interesting problems, which will doubtless ere long meet with satisfactory solution. The great problem of chemistry is to determine the connection between the structure and the properties of molecules. To take a special case, it may be asked, why is the hydrogen of acids replaceable by metals under definite conditions? Many facts are known which enable us to give partial answers to this question; doubtless, thermal investigation, taken in conjunction with other methods of research, will some day furnish the complete answer.

Thermal measurements have already shown us that allotropic changes in elementary molecules are accompanied with changes in the energy of these molecules, and that the same generalization holds good with regard to isomeric changes among compound molecules. But the whole question of allotropy is yet in its infancy.

The thermal method promises to throw light upon those phenomena which are classed together under the name of valency, and perhaps to furnish an answer to the query, Why does the valency of elementary atoms vary? The new method is full of hopeful anticipations.

M. M. Pattison Muir.

PEROXIDE OF HYDROGEN.*

By George E. Davis.

Many books tell us that H_2O_2 is made by a roundabout process with BaO_2 and HCl; this might have been in days gone by, but now it is made principally by means of barium peroxide and hydrofluoric or fluosilicic acids. An insoluble fluoride of barium or fluosilicate is formed which separates at once and peroxide of hydrogen remains.

Now, if hydrofluoric or hydro-fluosilicic acids have been used, we need not expect to find hydrochloric, as this latter can only be present when impure fluoride is used, impure acids or impure water. Of course it is absolutely necessary to examine carefully every sample of peroxide of hydrogen which may be purchased, for many statements have been made at various times respecting the purity of the bought article. One chemist assured me that the first lot he purchased was full of hydrochloric acid, while another chemist actually assured me that peroxide of hydrogen would not oxidize sulphide of sodium in vat liquors. More statements than these have been made respecting the efficiency of this reagent, but in each and every case it would have been more creditable to the author of the statement had he examined thoroughly the facts of the case before making complaint against one of the most useful articles used in chemical analysis.

Now, the first thing which requires to be estimated is the active oxygen, and this may be seen when I state that the sample which would not oxidize sulphide of sodium contained only a trace of active oxygen. Many methods may be devised for estimating the strength of this article. I have used the following three methods with satisfactory results:

1 c.c. was put into Crum's tube over mercury and run underneath the tap; then 5 c.c. of a saturated solution of bichromate of potash, the whole gently agitated, the liberated oxygen measured and corrected for temperature and pressure. In working on a certain sample as a mean of several experiments, 1 c.c. gave 8·2 c.c. of oxygen at 0° C. and 760 m.m.

By a second method 10 c.c. of the peroxide were boiled with 20 c.c. of sulphurous acid, and the sulphuric acid which was formed precipitated as barium salts and weighed, the sulphuric acid existing as such in the sulphurous acid being deducted from the precipitate. 10 c.c. oxidized 0·46 grm. SO_3, or 7·08 grs.

By a third method 10 c.c. of the peroxide oxidized 146 c.c. $\frac{N}{10}$ protosulphate of iron. Now, if we calculate these we shall find that our first method gives the strength of the solution as 8·2 volumes, and they all, when expressed as in grammes of oxygen per liter, show:

a. 11·72
b. 11·53
c. 11·68

* A paper read before the Faraday Club.

For general work the bichromate method is preferable, though when extreme accuracy is required the iron method may be employed if conducted in a stream of carbonic acid.

Now, as to the stability of peroxide of hydrogen. It has been stated quite recently, and by one of the members of this club, that it is so unstable that simply drawing air through a solution of it will abstract the whole of its active oxygen. I don't know what amount of air is considered necessary, but I should say a great deal, and neither do I know what tests he used to ascertain that there was no peroxide left undecomposed. An alkaline solution of peroxide is partly decomposed by agitation only, but an acid or neutral solution is very stable. An alkaline solution of peroxide has been used over a very long time in connection with a continuous aspirator. 10 c.c. of peroxide and the necessary quantity of water aspirated through at a speed of 15 cubic feet per 24 hours has shown an excess of peroxide at the finish of the experiment, even when caustic soda was present in excess also. I have evaporated a 10-volume solution of peroxide to half its bulk without driving off more than two-thirds of its active oxygen, but when reduced to that bulk caustic soda was added, the elimination of oxygen was so violent as to amount almost to explosion. When kept in solution in the laboratory a 10-volume solution of peroxide is moderately stable. During 1878 the following tests were made of a sample by the bichromate method over mercury:

August	2	9·0
"	9	8·4
"	24	8·0
September	1	7·9
"	24	7·8
October	24	7·2

A few drops of ether were now added to 250 c.c. of that sample of October 24, and the following tests continued:

November	7	7·2
"	24	7·2
December	1	7·2
"	24	7·2

Ether seems to preserve it, a fact which has been known for some time. This was also mentioned to me by Dr. Messel, of Silvertown, in August, 1878, a method I have used ever since. It is stated in all our text-books that peroxide of hydrogen is neutral to test papers. Now, all commercial peroxide is faintly acid with the excess of hydrofluoric or hydrofluosilicic which is added, and which should be estimated in each sample before using it.

I have used peroxide of hydrogen since 1873, and latterly in comparatively large quantities, and I have made it a rule to examine each purchase as follows: 100 c.c. of the peroxide was evaporated to dryness with 10 c.c. N soda, ignited, and taken up again with water. N acid was then added to neutrality, chromate of potash, and finally titrated with $\frac{N}{10}$ nitrate of silver. The results of many experiments upon this one sample showed that 100 c.c. of peroxide neutralized 0·2 c.c. of N soda and consumed 3·4 c.c. of $\frac{N}{10}$ nitrate of silver. On the evaporation to dryness of the peroxide by itself a very pungent acid is liberated, and which can be easily told is not hydrochloric. In order to show the moderate stability of peroxide of hydrogen, I have lately had a sample sent me of commercial peroxide which was at least fifteen months old. When treated with bichromate over mercury it gave 7 volumes of oxygen, and I know that no special care, or indeed care of any kind, was bestowed upon the sample.

Having, then, a ready method of testing its contained amount of active material, it remains only for me to show that peroxide of hydrogen is an exceedingly useful oxidizing agent, for it oxidizes by reason of its loosely combined oxygen, and when an excess is added to any substance or to any solution, that excess is readily eliminated, leaving only as a residue that most neutral substance water.

There are many substances often seen in the laboratories of alkali works that cannot be readily and accurately examined except by its use; such as the total alkali and crude soda liquors or in black ash, and certain qualities of soda ash which contain sulphides or sulphites. In the testing of chamber exits it is extremely useful, inasmuch as sulphurous acid is not an acid easily titrated, for the normal sulphite of an alkali is not neutral to test paper, and, therefore, on titrating a sulphite with a standard acid the point of neutrality is not clearly defined and distinct. This want of clearness in the ending has been stated by some chemists to be due to the carbonic and nitrous acids present in chamber exits, but add peroxide of hydrogen to the solution and all difficulty vanishes, the sulphurous acid is oxidized to sulphuric, which acid is easily titrated.

I will now proceed to give examples of its use in various methods of analysis. Some examples of soda ash contain so much sulphite of soda that it is impossible to estimate the amount of alkali accurately by means of standard acid. As an example of this kind of ash I give the following analysis of a sample of ash made from caustic salts, which contained by the acid test in the ordinary way 30 per cent. of alkali without peroxide of hydrogen, while the addition of a few c.c. brought down the actual percentage to 21. The escaping carbonic acid carries away a great deal of sulphurous acid, but it does not do this if peroxide of hydrogen is present.

Sodium	sulphide	0·008
"	sulphite	22·982
"	sulphate	2·207
"	chloride	33·048
"	silicate	1·214
"	carbonate	18·704
"	hydrate	12·890
Water		8·747
		99·800

Peroxide of hydrogen is very useful in the analysis of black ash; a few c.c. added to the liquor under examination gives at once the total alkali, which number needs no correction for sulphides, hyposulphites, etc.

This reagent is very useful for many laboratory oxidations, such as the oxidation of iron salts, coloring matters, experiments on bleachings, etc., etc. In fact the applications of this useful substance are legion. I first commenced to use this reagent for testing vitriol exits in 1873; but its application then was very limited, as I had to make my own, and a perfectly pure peroxide of barium is not a very easy thing to make. In those days peroxide of hydrogen was looked upon as a sort of *rara avis*, to be found only in the laboratories of schools of chemistry, and its use was not much extended until a pure peroxide of hydrogen entered the market as a commercial article, to be bought and sold in the same way as other reagents.—*Chem. News.*

NITRIFICATION.

AT a recent meeting of the Chemical Society, London, Mr. Warington read a paper "On Nitrification (Part II.)." A. Müller was the first to advance the opinion (*Chem. Soc. Journ.*, 1873, 1267) that nitrification is due to the action of a ferment. Schloesing and Müntz proved this to be the case (see Part I. of the author's paper), and from recent experiments show that soils which induce nitrification have this power destroyed by exposure for one hour to 100° C., and that ordinary moulds and mycoderms injure rather than promote nitrification. The author also mentioned that the above experimenters were at present engaged in an attempt to isolate and cultivate the organism, which promised good results.

The objects of the author were to ascertain the influence of light, temperature, variations in the composition, and concentration of the solutions on the process of nitrification, the rate at which it progresses, and the relation of the nitric acid produced to the ammonia consumed. In nearly every case exposure to light prevents nitrification, and in all cases the exposure hindered the process to a marked extent. The mould which develops in a solution containing tartrates is incapable of effecting nitrification. The presence of carbonate of calcium seems to be indispensable to the growth of the ferment. The author pointed out the significance of this fact as explaining the absence of nitrites and nitrates in soft peaty waters, and as bearing on the utility of applying lime, etc., to peaty soils rich in nitrogen, in a form unfavorable for absorption by plants. A very small amount of organic carbon is requisite. An extensive series of quantitative experiments is given as to the effect of temperature. The upper limit of temperature at which nitrification takes place has not been determined. 40° C. is, however, fatal to the process, which can proceed at 10°, and probably at still lower temperatures. In all cases there is a period after the addition of the ferment during which no appreciable effect is produced. This period the author terms the period of incubation. This period is considerably shortened by increasing the temperature. Thus, in a solution containing 640 milligrms. AmCl per liter, the period was, at 10°, 78 days; at 30°, 19 days. As the solutions become stronger the period increases. Thus, a solution containing 80 milligrms., the period was only 31 days at 10°, or 12 at 30°, instead of as above 78° and 19°. The presence of bacteria does not promote nitrification.

The author discusses the interesting question why in some cases nitrites, and in others nitrates, are produced. When the ammonia disappears before the nitrous acid is converted into nitric acid, the nitrites left in solution are very stable; if, however, the oxidation of nitrites sets in before the ammonia has been consumed, nitrates are formed with great rapidity. In no case is the whole of the ammonia obtained as nitric acid. Some experiments were made as to the part played by the heating effect of the sun's rays in preventing nitrification, as a temperature of 40° proved to be fatal. It was found that a solution sheltered partially from the heat, by a screen of alum solution, but fully exposed to the light of the sun, nitrified sooner than a similar solution exposed to the heat and light. In both cases nitrites were formed which were very permanent.

The paper concludes with some interesting experiments on the conversion of nitrites into nitrates by the ferment. This change takes place only in the dark, and a ferment which is quite competent to convert ammonia salts into nitrites is apparently not necessarily competent to convert the nitrites into nitrates. Some solutions, however, which are nitrifying seem to possess this power in a high degree. The progress of nitrification is not uniform; it begins slowly, increases in rapidity, and after reaching a maximum again diminishes. The strongest solutions nitrified by the author contained 180 parts of nitrogen per million.

TEST FOR MERCURIAL VAPORS.

AT a recent meeting of Society of the Physical and Natural Sciences of Bordeaux, M. Merget recommended paper steeped in the ammoniacal solution of nitrate of silver, or in chloride of palladium, as reagents for mercurial vapors much more sensitive than gold foil. This test paper is very sensitive; a slip of sheet-copper plunged into a liquid containing 1 part of mercury in 10,000 remained bright after immersion, but if exposed to the ammoniacal nitrate of silver paper it occasioned a characteristic black spot. He finds that even when solidified mercury emits vapors in appreciable quantity.

COMPOSITION OF A BOILER INCRUSTATION.

By ALFRED SMETHAM, F.C.S., A.I.C.

ON analyzing a boiler incrustation which was lately submitted to me for examination I found it, after drying at 100° C., to have the following somewhat unusual composition:

Oxide of iron	24·72
Oxide of lead	8·41
Oxide of zinc	44·39
Lime	0·99
Magnesia	0·77
Sulphuric acid	1·23
Carbonic acid	3·34
Insoluble matter in aqua regia	5·60
Water of combination, organic matter, and undetermined	10·56
	100·00

Before committing myself to an opinion as to its cause, I wrote to my clients asking them for particulars of construction of the boiler, and learnt in answer that it was a "hot water circulating boiler for domestic use," and, further, that the boiler and cylinder were constructed of "galvanized" iron, and communicated the one with the other by means of leaden pipes.

The explanation which I gave of the cause was briefly this: The town water, with which the boiler was fed, and which is soft to commence with, would, on boiling, be rendered still softer, and by constantly circulating through the leaden pipes would dissolve a small quantity of the lead. This, passing either into the cylinder or boiler, would be reduced to the metallic state by the zinc with which the iron is "galvanized," and a voltaic action would be induced, the zinc acting as the positive and the lead as the negative metal. By this means a rapid and increasing action would be set up, which after dissolving the zinc would act upon the iron in precisely the same way as the bottom of iron railings, fixed into stone by means of lead, are corroded at their lower ends.

It is thus easy to see how the deposit, which was of a foxy brown color and friable, would soon be formed, and the small amount of lime and magnesia salts which are mixed with it proves that the action must have been rapid.

If, as seems probable, there was any metallic lead in the deposit when first removed, this had become oxidized by exposure to the air, to which it was exposed for some time previous to analysis. From a rough sketch of the boiler and fittings which I received, it seems probable that the lead pipes were in metallic communication with the galvanized iron, and if so a much more general action, as well as the local ones before indicated, would take place, and destruction would occur at a proportionately greater rate.—*Chemical News.*

ARTIFICIAL PREPARATION OF MANGANIC PEROXIDE.

By A. GORGEU.

THE author produces this compound by heating nitrate of manganese in a glass phial, placed in an oil or paraffine bath, to 155° to 162°. He supposes that in the natural formation of polianite and pyrolute iron suspended in the very fluid mass of nitrate of manganese has been first drawn off, the decomposition of the manganous nitrate taking place subsequently.

EXCRETION OF PHOSPHORIC ACID IN THE HERBIVORA.

By DR. J. BERTRAM.

IN the carnivora the phosphoric acid introduced into the system is almost exclusively excreted in the urine, whilst in herbivorous animals, under normal circumstances, it appears in the solid excrements, and is not to be detected in the urine unless the lime present in the food is not sufficient for its neutralization.

PURIFICATION OF SACCHARINE JUICES WITH HYDRATE OF ALUMINA.

By DR. O. KOHLRAUSCH.

THIS process, introduced by Prof. Löwig, dispenses with animal charcoal and with the production of treacle. The author finds, however, that a certain quantity of alumina dissolves in the juices, so that the mineral acids present and also the color are not entirely removed. Hence it is very doubtful whether the filtration over animal charcoal could be omitted. The production of treacle is also not obviated in Löwig's process. The elutriation of the hydrate of alumina requires such quantities of liquid that the boilers and presses would require to be enlarged, and the consumption of fuel would be increased.

THE MANUFACTURE OF MAGENTA BY COUPIER'S PROCESS.

By DR. C. HAEUSSERMANN.

THE author remarks that Coupier's process has hitherto been adopted in but few establishments, and although the magenta thus produced is often preferred, especially as a raw material for the preparation of superior blues, it is not yet finally decided which of the two methods is preferable. For Coupier's process it is essential to use an aniline oil of sp. gr. 1·006 to 1·007 at 15°. It is converted into hydrochlorate with the presence of as little water as possible. To prevent the aniline hydrochlorate when dehydrated by a temperature of 140° from adhering too firmly to the sides of the vessel, two-thirds of the aniline to be used is slightly supersaturated with hydrochloric acid, concentrated till the temperature rises to 140°, and the remaining one-third of the aniline is then poured into the melted cooling mass. This operation is conducted in enameled pans provided with a condensation apparatus. The mixture of aniline and aniline hydrochlorate is then introduced into the melting pans, adding to 100 parts of aniline about 50 parts of pure nitro-benzol, and by degrees 3 to 5 parts of iron filings.

ANALYSIS OF ORGANIC BODIES CONTAINING HALOGENS OF NITROGEN.

By HUGO SCHIFF.

THE author describes with slight modifications the method proposed by Piria thirty years ago. The substance is weighed in a small platinum crucible, and in case of chlorine or bromine fills up with a mixture of one part anhydrous carbonate of soda and four to five parts of lime, the whole being thoroughly mixed together by means of a platinum wire. The whole is then covered with a larger platinum crucible, and the pair are inverted so that the bottom of the larger crucible is turned downwards. The space between the two crucibles is filled with the same mixture of lime and soda, the lid is put on, and the whole heated to redness over a strong Bunsen burner. The reaction is completed in about ten minutes. In case of an iodine compound carbonate of soda is used without lime. The arrangements for the determination of nitrogen cannot be intelligibly described without the aid of the plates.

THE MOLECULAR MAGNITUDE OF INDIGO.—Dr. E. v. Sommaruga.—The author finds the vapor density of indigo = 9·45, and concludes that the formula for indigo must be $C_{16}H_{10}N_2O_2$, and not the half of these numbers.

RELATIONS BETWEEN THE CHEMICAL COMPOSITION AND THE MECHANICAL PROPERTIES OF STEEL.

By V. DESHAYES.

CARBON renders steels rigid and elastic, increasing their elastic tension, but their resistance to rupture diminishes if 0·500 is exceeded. Manganese renders steels rigid and elastic and increases their elastic tension, but the elongation and contraction remain considerable, which gives a good resistance to a shock. Silicon plays the same part as carbon, rendering steels hard, and slightly diminishing elongation. Sulphur decreases the breaking strain and the resistance to a shock. Phosphorus renders steels deficient in body, and, if its proportion exceeds 0·250 per cent., fragile on receiving a shock. Chrome acts like manganese, but more energetically.

ON THE ELIMINATION OF PHOSPHORUS IN THE BESSEMER CONVERTER.*

By SIDNEY G. THOMAS, F.C.S., and PERCY C. GILCHRIST, Associate Royal School of Mines, F.C.S.

THE non-removal of the phosphorus in the Bessemer converter, owing to which the great bulk not only of British, but of French, German, and Belgian ores, are still unavailable for steel making, is a fact too familiar to metallurgists to need insisting on. The inquiry whether this unfortunate circumstance is due to causes absolutely inseparable from the conduct of the Bessemer process, or to others which are merely the accidents of a particular mode of constructing the apparatus, is obviously of vital importance. If the non-elimination be due to the intensity of the temperature, or to the short duration of the operation, or to both these causes combined, it is almost hopeless to expect that we shall ever be able to use ordinary unpurified pig iron in the converter.

That it is to these essential accompaniments of the process that the phenomenon of the retention of phosphorus by Bessemer metal is to be ascribed is, it is believed, the generally received opinion, and one which has comparatively recently received the sanction of the weighty authority of such eminent metallurgists as Mr. Lowthian Bell, Dr. Wedding, Prof. Kerl, and M. Euverte.

An examination of the general condition attending the removal of phosphorus in puddling and refining operations, taken in connection with the well-known action of silica on phosphate of iron at high temperatures, and the fact that in many other processes in which the temperature is very high, the elimination of phosphorus is not apparently effected, seems, however, to justify the belief, which has doubtless suggested itself to other members of this Institute, that it is to the silicious lining of the ordinary converter, and to the consequent necessarily silicious character of the slag, that one defect of the Bessemer process is due. Under this conviction, at all events, experiments were commenced by the authors about three years ago on the effect of basic lining and basic additions in the several steel-making processes. Unfortunately the appliances at command were of a very imperfect character, and the results obtained, though highly encouraging, were, owing to defects in the miniature converter employed, which prevented our ever completely finishing a blow, not entirely conclusive as to commercially complete purification being possible.

While waiting the completion of an improved converter, which was unavoidably delayed for some time, we were encouraged by finding that M. Grüner, the distinguished professor at the Ecole des Mines, of Paris, in his "Treatise on Steel," published in 1867, laid great stress on the injurious influence of the silicious character of the cinder and lining in the converter. M. Grüner, however, seems at that time to have regarded this as one only of three causes which prevent elimination of phosphorus, and proposes as a remedy the preliminary refining of phosphoretic pig before it is attempted to convert it.

With a new converter, a large number of experiments were made in the autumn of last year, which gave much more definite results. The lining used in these experiments consisted of limestone and silicate of soda, a mixture which had been found to answer well in earlier trials.

On laying some of the first of the results obtained from this six-pound converter before Mr. Martin, of Blaenavon, he at once recognized their importance, and from that time we have been deeply indebted to him for his unfailing and consistent support, and much valuable advice and assistance. The Blaenavon Company, also, without hesitation, undertook to put up apparatus to carry the experiments further, and has with great spirit fulfilled its promise to give every facility to test the value of the theory thoroughly.

In a vertical converter, taking from 3 cwt. to 4 cwt. of metal, results entirely confirmatory of those previously observed were obtained. In the six-pound converter liquid decarbonized iron could not be obtained; but in the new vertical converter this was readily done.

Some fifty or more blows were made in this vertical converter, and the products analyzed; and it was found that, using a basic lining, it was generally necessary to continue the blow for over forty seconds after the flame dropped in order to bring the phosphorus down very low. With this proviso the elimination of phosphorus could be secured with absolute certainty. With a silicious lining the retention of all the phosphorus in the metal was, as usual, equally invariable, even when, as in Mr. Bell's experiments, the blow was continued till a considerable proportion of the iron was oxidized. At the same time, more phosphorus and less silica would be found in the slag obtained under these conditions than appears to be the case when large quantities of metal are treated under similar circumstances.

Using a lining consisting of one part fire clay and two of ganister, and a pig containing 1·44 per cent. of phosphorus, the blown metal contained 1·63 per cent. of phosphorus and the slag 32·5 per cent. of silica, and 0·85 per cent. of phosphorus. When, however, with the same lining 40 lb. of lime was placed in the converter before the pig was run in, though the lining wore away very much (as might be expected), there was a decided decrease of phosphorus in the blown metal, as shown below:

	P.		P.		P.	SiO_2.	CaO.
Pig used;	1·44	Blown metal,	1·23	Slag,	0·99	30·7	18·8
"	—	"	1·07	"	1·81	31·0	25·1

It would seem that the presence of a considerable amount of lime in a not too silicious slag is highly favorable, and on a large scale essential, to the removal of phosphorus. As it was manifest that phosphorus was not removed until the slag was sufficiently basic, the effect of large basic additions in combination with a basic lining was tried, with the object not only of obtaining a highly basic slag at an early stage of the blow, but of rendering the operation independent of the wear of the lining, by which alone the basic character of the slag is otherwise obtained and maintained. Advantage was taken of the fact that lime and oxide of iron are fusible in many proportions. The mixture generally used consisted roughly of one part by weight of "Blue Billy" and two of lime; this will melt in an iron crucible, and may be readily added in a molten condition. It was found that by throwing into the converter cheap basic materials consisting mainly of lime, even without previous heating, before the pig was introduced, very satisfactory results were obtained without over-blowing.

By using these basic additions, a large proportion of the phosphorus is eliminated while yet a considerable proportion of the carbon remains, a result which had otherwise only been obtained when there was a very considerable waste of lining.

* A paper read before the Iron and Steel Institute. (Condensed.)

With a 12-cwt. converter of the ordinary pattern, expressly put up by the Blaenavon Company, only a limited number of casts were made, owing to a deficiency of blast.

By the kindness of Mr. Menelaus, for whose kindly assistance we have to tender our sincerest thanks, we were enabled to try, at the old No. 3 pit at Dowlais, if the superior intensity of heat which might be expected from the conversion of 5 or 6 tons of metal at a time affected the conclusions to which smaller experiments pointed. It was intended to line this converter with highly burnt basic bricks. The bricks intended for this purpose were, however, accidentally underburnt, and so spoilt; hence recourse was had to a rammed lining of limestone and silicate of soda. This lining, which consisted of a silicious limestone mixed with 9 per cent. of a solution of silicate of soda, would, after the carbonic acid was driven off, contain nearly 20 per cent. of silica. This, by greatly diminishing the effect of the ordinary wear of the lining in making the slag basic, rendered larger basic additions necessary than it was deemed prudent to make in the first two blows. In the first blow about 2 cwt. of lime were added cold, and in the second nearly 2 cwt. of lime and 1 of Bona ore. The slag was decidedly silicious in both cases, and, of course, only a minute quantity of phosphorus was removed.

	Pig Used.		Blown Metal.		Steel.	
Blows.	I.	II.	I.	II.	I.	II.
Si	2·97	2·62	trace.	trace.	trace.	trace.
P	1·21	1·21	1·21	1·19	1·11	1·11
C	—	—	none	under 0·10	0·54	0·42
S	0·06	0·10	0·50	0·10	0·05	0·09

Mr. Jenkins, of Dowlais, has kindly furnished us with his analyses of the same blows. He finds 1·08 in the steel from the first blow, and 1·03 in the steel from the second blow.

The cinder, with the steel, contained in the first blow 38·8 per cent of silica, and in the second blow 36·18. The pig used was too high in silicon for phosphorus to be readily removed, without very large additions of lime.

In the third blow 3½ cwt. of a mixture of two parts of lime to one of roll scale were thrown into the converter before the metal was run in. The metal was blown for eight or nine minutes and turned down (before the flame dropped). Nearly another 3½ cwt. of the same mixture was then thrown in, and the vessel again turned up, when the flame dropped almost immediately. After being turned down for some fifty seconds, it was (at Mr. Martin's suggestion) again blown for nearly a minute. Though it appeared that the metal was overblown, the action, on adding spiegel, was not violent. A large skull was, however, left in the converter and ladle, and much slag was produced. The blow lasted ten and a half minutes. A rail made from one of the ingots deflected 9⅝ inches with the blow of 1-ton ball falling 24 feet, the bearings being 3½ feet apart. It was considered much too soft for rails.

The skull left in the converter was got out by blowing a charge of very silicious non-phosphoretic pig. In the next (fifth) blow, 1 cwt. of a mixture of two of limestone and one of Elba ore was thrown into the converter, before the metal was run in; rather over 3 cwt. of heated roll-scale was added subsequently, before the completion of the blow. During this blow the lining had to be patched at the breast.

The results appear to confirm the conclusion that, for the process to be of technical value, waste of lining and metal must be avoided by making large basic additions, so as to secure a highly basic calcareous slag at an early stage of the blow. In these trials, however, it was thought prudent to feel the way, and not add at once the very large amount of base which our theory demanded, the more so as we were not able to add the bases in the molten state. It is also made clear that a slag containing under 14 per cent. of iron may be very effective in removing phosphorus.

After the five blows described the lining was found to be much worn, and not in a condition to admit of satisfactory repairs. Two tuyeres had to be renewed in the fourth blow; the rest stood well.

It is obvious that without a sufficiently durable, as well as refractory, basic lining, the simultaneous dephosphorization and conversion of cheap pig in the Bessemer vessel cannot rank as a commercial process. Our early experiments rendered it clear that ordinary non-silicious lime and limestone did not constitute by themselves a satisfactory lining material; nor were renewed trials, made after becoming acquainted with a patent dealing with their application, more successful. Magnesia, the use of which as a furnace lining has been suggested by M. Caron and others, is at once very expensive and—when used by itself—very tender. Nor did we, after repeated attempts, find it at all practicable on the large scale to use oxide of iron linings in any of the forms in which they have been used in puddling furnaces. After a very extended series of trials* it was, however, found that, by firing bricks made of an alumino-silicious limestone at a very intense white heat, a hard and compact basic brick is formed. These bricks unfortunately labor under the defect of a liability to disintegration when exposed to the action of steam. By the use of certain aluminous magnesian limestones and equivalent combinations, and an otherwise similar mode of manufacture, this difficulty has been overcome. For certain purposes magnesian limestone, mixed with silicate of soda solution, forms an excellent material. To enter fully into the important subject of the precise conditions necessary for obtaining a satisfactory basic lining would exceed our limits, and the consideration of this, as of many other interesting points, must be reserved. The question of how far the heat due to the oxidation of phosphorus may replace that due to the combustion of silicon, the possibility of using in the converter low phosphoretic pig low in silicon, and the influence of silicon on the removal of phosphorus, are some of the subjects on which much remains to be said.

In advancing the proposition that the technical removal of phosphorus in the Bessemer converter is simply and entirely a question of cheaply producing a highly basic slag, containing under 20 per cent. silica and over 30 per cent. of lime and magnesia, and indicating the means by which this may be secured, we are not aware that we can shelter ourselves under any very distinct authority, though surmises as to the hypothetical advantages that might be expected, were the Bessemer slag less silicious, have not been wanting. It is, however, only proper that we should remind the Institute that Mr. Snelus stated at its March meeting, simultaneously with ourselves, that he had removed phosphorus in a Bessemer converter lined with limestone. Of the circumstances of this experiment we are in ignorance. It is on the production of a basic earthy slag, by the addition of large quantities of calcareous bases, and without excessive waste of lining and metal, and the construction of a durable basic lining, that we venture to think the economic solution of the phosphorus problem depends.

* For most valuable assistance in these, as at every period of this investigation, we are especially indebted to Mr. Thomas Griffiths, engineer at Blaenavon. We take the opportunity of at the same time thanking Mr. Gill, assistant in the Blaenavon laboratory, for his aid in the many hundreds of analyses made in the course of our inquiry.

It need hardly be said that the theory here advanced as to the practicability of commercially removing phosphorus in the converter extends, *mutatis mutandis*, to the Siemens and other open-hearth processes, where, in fact, many difficulties that are met with in the converter are absent. Dr. Siemens has indeed suggested the use of a lime lining in one of his furnaces, though he has since, with his customary candor, informed us that he has failed to find means for its successful application. The present paper will have fulfilled its purpose if it induces metallurgists to reconsider the verdict, so fatal to the hopes of steel makers, that "oxygen, whether in its free state or as oxide of iron, is almost entirely inert as regards phosphorus at the intense temperature which accompanies the Bessemer process."

In the nine months that have elapsed since our paper on the "Elimination of Phosphorus," etc., was prepared, the vigorous co-operation of Mr. Windsor Richards and Messrs. Bolckow Vaughan has enabled the authors to submit to the Institute further evidence in support of the views then put forward. That intensity of temperature is no obstacle to the removal of phosphorus, but, under proper conditions, highly favorable to this end, has been abundantly demonstrated by the results of the working at Middlesborough. It is indeed found that, other things being equal, the hotter the blow the better is the result. As regards the necessity for large additions of bases consisting mainly of lime, the experience afforded by some seventy or eighty operations is equally conclusive.

In continuation of some smaller experiments carried out in 1877 at Blaenavon, trials have been made of the effect of largely increasing the amount of oxide of iron added to the commencement of the blow, and diminishing the lime so as in a measure to assimilate the cylinder to that of a 'puddling furnace. As was anticipated, it was found that this could not be done successfully. In the first place, the loss from excessive boiling was very great; in the second, the phosphorus is only very imperfectly removed. A very considerable amount of ore may, however, be added after the greater part of the silicon is removed. The amount of bases which it is necessary to add with Cleveland pig generally exceeds considerably 2 cwt. per ton of pig treated, the exact amount being dependent on the wear of the bottom, and the percentage of silicon and phosphorus in the pig. The presence of an excess of earthy base in the slag seems an essential condition of success. The formation of a very fluid basic slag at an early stage of the operation is also of great importance, as it enables the phosphorus and carbon to be oxidized *pari passu*, or nearly so. It will be borne in mind that the basic addition has a double function; in the first place, to preserve the lining; in the second, to form a highly basic earthy slag, so as to afford a strong base with which the phosphoric acid may unite at the moment of its formation. On several occasions the experiment has been made of blowing in a basic brick lining without, or with very small, addition. The result is always excessive damage to the lining and a trifling removal of phosphorus. The density and compactness of the present lining material prevents it from playing the important part in the actual formation of the basic slag which was fulfilled by the softer and less durable linings first experimented on. The highly-fired magnesian lime bricks have, we venture to think, more than fulfilled all the expectations which were entertained as to their probable value.

It has also been ascertained that, providing a highly earthy basic slag is present, the removal of almost the last traces of phosphorus may be secured by continuing the blow for some time after the drop of the flame. The phosphorus in the presence of a strong base seems to protect the metal much in the same way as carbon and silicon, so long as there is present an excess of a strong base with which the phosphoric acid can unite at the moment of its formation: When, however, the phosphorus is reduced very low, the iron begins to oxidize as in an ordinary case of over-blow.

The question of the elimination of phosphorus being the primary matter with steel makers, it is not proposed to do more than to mention that, under the circumstances which have been described as essential to the removal of phosphorus, a considerable proportion—viz., from 30 to 70 per cent. —of the sulphur is also removed. Certain experiments made by the authors in conjunction with M. Ponsard, in November last, with a Ponsard furnace—in the first of which over 20 per cent. of the phosphorus and 59 per cent. of the sulphur were removed under very unfavorable conditions—quite confirm the opinion formed from smaller experiments, that the system described is as applicable to the open hearth as to the Bessemer furnace. Those open hearth furnaces which are provided with removal hearths offer peculiar facilities for the adoption of a brick hearth or lining.

ON THE GASES INCLOSED IN IRON AND STEEL.

SOME very unexpected results of exceptional importance have been obtained quite recently by Prof. F. C. G. Müller, who publishes in a recent number of the *Berichte der Deutschen Chemische Gesellschaft* a preliminary communication on his examinations of the quantity and composition of the gases inclosed in iron and steel. He collects the gases in the following manner: After casting a 2-inch sample ingot the steel is cooled in water, and while still warm is coated with wax. The ingot is then fastened in the spindle of a strong drilling machine, and a hole is drilled into it under water, the drill operating from below, so that the gases remain in the cavity formed. From the latter they are carefully removed into a suitable vessel and analyzed by Bunsen's method. Prof. Müller has thus collected and analyzed the gases from twelve specimens, the results of some being the following:

	1	2	3	4
Hydrogen	88·8	77·0	67·8	83·3
Nitrogen	10·5	22·9	30·8	14·2
Carbonic oxide	0·7	—	2·2	2·5
Volume of gas in per cent. of volume of metal	60	45	25	35

No. 1 was Bessemer steel before the addition of spiegel. No. 2, Bessemer steel from the same charge, after an addition of spiegel. No. 3, open-hearth steel, and No. 4, pig iron from the cupola.

It will be seen that the volume of gas obtained was large beyond all expectation. By weighing the amount of metal drilled out, and by measuring the cavity, it was ascertained that the pressure of the gases averaged eight atmospheres. It is astonishing how solid some brands of pig iron are. In

a sample of Hollway No. 1, only 3·5 per cent. of gas, containing 52 per cent. of hydrogen, 4 per cent. of carbonic acid, and 44 per cent. of nitrogen were found.

When the first experiment showed that the gas obtained was almost pure hydrogen, Prof. Müller doubted the accuracy of his methods. Believing that it might be possible that the hot drillings decompose the water, he used oil for the next experiment, but found that his results were not affected. The figures varied but little, whether the material was hard or soft Bessemer metal, or whether it rose slowly or foamed. The lowest results obtained were those of No. 3, while the highest was 90·3 per cent. of hydrogen. If verified, they will completely upset all the opinions held hitherto in regard to the gases causing blow-holes in steel. All efforts to make steel castings sound by chemical means have been based upon the supposition that the gas causing the formation of blow-holes was carbonic oxide. Such chemical reactions as the one presumed, in order to explain the action of silicious additions at Terre Noire ($Si+2CO=2C+2SiO_2$), would have to be dismissed as erroneous.

NOTES OF PRACTICE AND PECULIARITIES OF TREATMENT AT PHILADELPHIA HOSPITAL.*

WARDS FOR DISEASES OF THE NERVOUS SYSTEM.

THE cases found in these wards, which are in charge of Dr. Charles K. Mills, neurologist to the hospital, are chiefly examples of chronic organic disease of the nervous system—hemiplegics from hemorrhage, thrombosis, or embolism; cerebral, cerebro-spinal, and spinal scleroses; meningitis, meningo encephalitis, and meningo-myelitis; epilepsy, hystero-epilepsy, and hysteria; brain tumors, spinal softening, and the like. Acute cerebral and spinal disorders; neuralgias, peripheral paralyses, local spasmodic diseases, and similar affections, are sometimes, but not so frequently, represented.

ELECTRICITY.

In connection with the wards, a large apartment, known as the electrical room, has been fitted up. It contains one of Flemming & Talbot's permanent batteries of sixty cells, and a fine faradic instrument from the same manufacturers. The wards are also supplied with portable galvanic and faradic instruments.

Dr. Mills, during the past year, has used electricity with marked success in the treatment of bed sores, which, in spite of the best of care, are apt to form in cases of spinal and cerebral disease. The "silver and zinc plate" method is the one generally employed, a silver plate being placed over the sore, and a zinc plate (connected by a wire with the silver) on a piece of acidulated chamois skin or paper lint, which rests on the unbroken skin a few inches above. A weak current from the galvanic battery is sometimes used instead of the plates. A silver plate applied to the sore is connected with the negative electrode, an ordinary rheophore, joined to the positive pole, being placed upon the surface near. The séance is continued for from five to ten minutes daily. Many cases of chronic ulceration put into the hands of the neurologist for electrical treatment have been cured by the galvanic plates, or the use of the battery current. Electricity is very effectual in stimulating healthy granulations.

Faradization is used in the wards to improve the condition of palsied muscles; and central galvanization is employed chiefly in spinal affections.

METALLOSCOPY AND METALLOTHERAPY.

Numerous experiments in metalloscopy and metallotherapy have been made in the nervous wards, only a few of which can be alluded to at present.

In one case of brain tumor with partial anæsthesia of the left leg, a small zinc plate applied to this limb in an hour caused a sensation which was described by the patient as being like that produced by the "battery," referring to a faradic instrument. Other metals were tried, but had no effect. The salts of zinc were used without success, iodide of potassium being the only remedy that seemed to help the case.

Some curious results were obtained in a number of cases of marked anæthesia from hysteria and spinal disease, to two of which reference will here be made.

One case was that of an unmarried woman, aged twenty-nine, supposed to be an example of hysterical paraplegia and anæsthesia. On two occasions plates of zinc, iron, copper, tin, silver, and gold, of about the same size and weight, were placed on different parts of the body simultaneously; at other times the applications were varied—sometimes one plate, sometimes two or three were used. Many trials were made, the patient being blindfolded, and different locations being selected for the same plate. In five instances the patient picked out the zinc plate in from twenty to forty minutes, saying that she felt under it a sensation which she described as tingling, or as like "pins and needles." Twice she referred similar, but weaker, sensations to the plate of iron, but other metals gave no result.

Sensation was temporarily improved, muscular power was apparently increased; and the anæsthetic limbs bled more freely, on pricking them with needles, after the zinc was applied, until the peculiar sensations described were called forth. This patient was kept upon the use of valerianate of zinc for six weeks—sensation, motion, and her mental condition improving. Subsequently, however, she relapsed.

A second case was that of a man, aged twenty-eight; an advanced case of sclerosis of the posterior columns, with almost absolute anæthesia of the lower extremities. After carefully testing the condition of sensibility and of the circulation, a small zinc plate was applied to the right calf, and a silver plate of the same size to a corresponding part of the left leg. In thirty minutes he began to have a sensation as if needles were pricking him under the silver plate. Two or three minutes later he had a similar, but weaker, sensation under the zinc on the right limb. The plates were kept on ten minutes, during which time he had four alternations of sensation in the two sides. When the pricking sensation was present under the silver plate it would be absent under the zinc, and vice versa; but it was in each instance much more decided under the silver. On removal of the plates electro sensibility was decidedly improved. No change of sensibility to the æsthesiometer or state of the circulation was produced. The symptoms in this case were decidedly ameliorated by both nitrate and oxide of silver, but were not permanently benefited by any treatment.

Dr. Mills does not believe that the theory of "expectant attention" will explain satisfactorily all the phenomena which result from metallic idiosyncrasies—whatever may be the explanation. Anæsthesia, even when the result of organic disease, can be temporarily removed by applying pieces of metal. He has observed that two metals will sometimes produce similar effects on the same individual; but, even in these cases, he has always found that one of the two will give rise to more decided sensations, and will be more positively effectual in removing the anæsthesia.

In regard to internal metallotherapy, it is somewhat difficult to arrive at a decision. Irrespective of metalloscopic investigations, the value, in chronic spinal diseases, of the preparations of zinc, silver, and other metals, has long been known. They can also be used with advantage in cases in which no effect is produced by external applications of metals. The salts of silver and zinc will undoubtedly bring about amelioration of serious symptoms in cases in which these metals, when applied to anæsthetic limbs, will be selected by patients in preference to others because of the peculiar sensation which they cause.

MASSAGE AND SWEDISH MOVEMENTS.

Both massage and Swedish movements are employed to a considerable extent, some of the nurses being trained for this work. Massage is found to be of benefit, even in old cases of paralysis, serving to keep up nutrition and temperature, and preventing trophic changes. In neuralgic and hysterical cases it also often proves of great service.

In the same room in which the permanent electrical instruments are kept, are some simple forms of apparatus for the movement treatment, such as a cross bar adjustable at various heights, a leaning cylinder for exercising the muscles of the trunk, a stool of the proper height and size for sitting movements, and a lounge or couch so hinged as to be capable of being inclined at various angles. The patients are taught to practice movements with or without assistance, according to the nature of the case.

A movement treatment, without apparatus, is also often used. The kinds of movements usually resorted to, without appliances, are the passive, or the duplicated active. Systematic passive movements are employed for the purpose of preventing, as far as possible, atrophy and deformities. Joints are kept in a healthier condition through the agency both of massage and these passive movements. Duplicated active movements are used in those cases in which the loss of power in sclerotic or paralytic patients, for instance, is not absolute. In conjunction with faradization this method of treatment often results in the marked improvement of the paralyzed limbs, palliating symptoms, and improving circulation and nutrition even of palsied limbs.

THE ACTUAL CAUTERY.

The actual cautery, either alone or conjoined with other remedies, is frequently resorted to in the treatment of epilepsy, and of chronic spinal diseases. The ordinary cautery iron, with a button shaped like the blunt end of an olive, has usually been employed, but recently the hospital has obtained a Pacquelin cautery, in which the vapor of pure benzine is forced by an air blast upon a piece of hot platinum. Superficial applications to the nape of the neck, or along the spinal column, are made every two or three days. The intervals between epileptic seizure have been extended from days to months by the use of the cautery.

THE TREATMENT OF SYPHILITIC BRAIN DISEASE.

The wards are nearly always well supplied with syphilitic affections of the brain and cord. Iodide of potassium in energetic doses is largely employed. Mercurial inunction has also been extensively tested, and in a few instances with striking results. From half a drachm to a drachm and a half of mercurial ointment is used daily, or every other day, the treatment being persisted in until some effect is produced, or good reasons arise for its discontinuance. Before inunction, the parts to which the ointment is to be applied are well sponged with warm water. Strict attention is paid, at the same time, to diet and hygiene.

TREATMENT OF SPINAL SCLEROSES.

For the various forms of spinal sclerosis, and particularly for posterior spinal sclerosis, or locomotor ataxia, the salts of silver—the nitrite, phosphate, or oxide—are generally found to be the most efficacious internal remedies. They are used in doses of from one-third to one-half a grain, and are often combined with some bitter tonic, as the extract of gentian or quassia. Electricity, in the form of moderately strong galvanic currents, is also much used; stabile currents to the spine and labile currents to the limbs being the most common methods of application. Early in posterior sclerosis large doses of ergot are often prescribed.

THE TREATMENT OF CEREBRAL AND SPINAL EXHAUSTION.

Preparations of phosphorus are used in the treatment of cases which show signs of cerebral or spinal exhaustion. A favorite preparation of this substance is the oil of phosphorus of the Prussian Pharmacopœia. This oil is administered according to the following formula, which is also used at the hospital of the University of Pennsylvania:

℞. Olei phosphorati .... ♏xvj.
Olei gaultheriæ .... ♏viij.
Mucilag. acaciæ, q. s. ad .... f. ℥j.
M.
Sig. One to two teaspoonfuls three times daily.

The oil of phosphorus itself can be prepared by the following process: "Into five fluid drachms of pure almond or olive oil, contained in a glass flask, drop three grains of transparent phosphorus. Place the whole in a water bath at 175° F., and agitate until dissolved."

CALABAR BEAN IN DEMENTIA PARALYTICA.

Calabar bean is prescribed in dementia paralytica, cases of which, in the early stages of the disease, sometimes find their way into the nervous wards. If not promptly relieved, they are transferred to the insane department. Pills of the ext. physostig. venenas, each containing from the one-sixth to the one-third of a grain, are given three times daily, the treatment being persistently continued and the effects of the drug constantly watched. Rest, nourishment, and counter irritation to the head or nape of the neck are conjoined with the calabar bean.

GENERAL NOTES.

Cannabis indica, hyoscyamus, conium, morphia, chloral, and bromide of potassium are used to fulfill various indications, such as tremor, headache, sleeplessness, mental symptoms, etc.

APOPLEXY.

In the treatment of the apoplectic state, the patients do not stand depletion well. Bleeding is seldom employed. Supporting measures are often found to be necessary to carry the cases successfully through the attacks.

* Reported for the *Medical Record*.

VALUE OF REST IN THE TREATMENT OF DISEASE.

By ARTHUR E. T. LONGHURST, M.D.

THE principles of treatment advocated by Professor Hilton in his lectures on "Rest and Pain," doubtless contributed very materially to the successful issue of many a serious and important case in surgery, and the study of mental disease has taught us much of the value of rest, but the practice of medicine has not, perhaps, yet derived its full measure of benefit from an application of the principle of rest in the treatment of disease. Yet, in the study and teachings of medicine, as in other scientific research after truth, if we only observe and follow out natural laws and indications, we shall have much that will guide us to what must be at least a rational course. Let us also bear in mind the teaching of the author mentioned, that practically the maximum of result is co-equal with the minimum of disturbance, and that rest becomes the great fosterer of repair.

In speaking of the advantages of rest in the treatment of disease, I desire to use the word in its most comprehensive sense, and in considering the principal diseases and affections of any of the great systems of the body, we cannot fail to see the importance of rest for the work that nature has to do, both in repelling the attacks of disease and in completing the work of repair. In affections of the brain and nervous system, whether as the result of injury or disease alone, or of both causes combined, is there any single agent of treatment so valuable as rest? Take, for instance, perhaps, the slightest of cerebral affections, "concussion." What a lengthened rest of mind and body is very often necessary to recover, or for the prevention of serious disease. In "compression," due to fluid extravasation, of what vital moment is rest. Equally, in affections of the membranes or substance of the brain, or in that state of arterial tension and inequality due to fibroid or other degenerative change in the bloodvessels, which is too often the forerunner of apoplexy, rest is our first consideration. Again, in conditions of extreme nervous exhaustion, as in the overwrought brain, or in delirium tremens, of what value is rest—when even opiates sometimes fail to induce that most perfect state of rest, sleep, and we obtain it by placing the sufferer as far as possible in a condition of mental and bodily quiet, and by giving milk and other easily assimilated nourishment, with or without chloral and bromides. In affections of the spinal cord and its membranes, how often has a lengthened rest in the horizontal posture been followed by recovery.

In affections of the circulatory system, we have an example of a twofold character. The heart itself, obtaining no lengthened period of repose, is less amenable to treatment, even of the nature here advocated. The bloodvessels, on the contrary, are most favorably influenced by certain postures in which they obtain rest, and disease is modified accordingly, as shown in the recumbent treatment of aneurism of the aorta, or in the complete rest given to the sac which follows the surgeon's ligature of the smaller vessels.

In the respiratory system the importance of the principle of rest is seen in the need of quiet, in the absence of conversation, and in the use of nervine sedatives in irritable states of the respiratory tract of the medulla, as in spasmodic asthma, whooping-cough, etc. Affections of the digestive and urinary systems also are very markedly influenced by certain conditions and treatment which give rest to the troubled viscera—notably certain states of the stomach in which vomiting is a distressing and urgent symptom. Yet how sensibly and often speedily is it relieved by withholding all ingesta for a time, and by covering the epigastrium with a warm soothing poultice or an application of belladonna, or other sedative acting on the ganglionic nervous centers. The liver, over stimulated by dietetic excess or indiscretion, loses its proper rest and becomes disorganized unless by a change in the mode of life rest can be secured for it. The kidney, too, if its functions are disturbed by the abuse of alcoholic drinks entailing an unnatural and continued strain on its organism, alike suffers from loss of rest, undergoing permanent degeneration and decay.

In affections of the serous membranes, especially in acute inflammations of their structure, how important an agent is rest; and if, in pericarditis, we can moderate the heart's action; or, in pleurisy, diminish the frequency of respiration by the employment of sedatives, thus giving a measure of rest to the inflamed and sensitive membrane, we shall doubtless aid nature in her effort, and lessen the probabilities of damage to the structures involved.

I have said that I desire to use the word rest in its most comprehensive sense, and the following mention of some of the varieties of rest obtainable in the treatment of disease will give expression to my meaning:

1. Mental rest.
2. Bodily rest.
3. A combination of the above, as in that most perfect state of rest which we call "sleep."
4. Organic rest, as evidenced in the avoidance of exertion in cardiac disease; of talking, in affections of the respiratory tract; and in limiting, so far as possible, the act of deglutition in affections of the alimentary tract by the substitution of enemata.
5. Local rest, as secured by change in the position of body or limb, the use of pillows, cushions, etc.
6. Dietetic rest, by avoiding the too frequent use of food and drink.
7. Medicinal rest, in the relief of spasm by inhalations and the not too frequent administration of medicines to the prejudice of nutrients or stimulants. By a consideration, then, of the question as to the manner in which the principles of rest above indicated may be best applied in each special case of disease, we shall no doubt conduce very materially to the relief and comfort of the sufferer, as well as to the arrest of diseased action.—*Lancet.*

THE GUAIACUM AND OZONIC TEST FOR BLOOD.

To the Editor of the Scientific American:

My attention has been directed by Mr. C. R. Blackett, late president of the Pharmaceutical Society of Victoria, to article 6415 in Dick's "Cyclopædia of Practical Receipts," which incorrectly assigns to Professor Bloxham, of King's College, London, the credit of having devised the guaiacum and ozonic ether test for the detection of blood in criminal investigations. That the credit is really due to me can readily be shown by a reference to the last edition of either Professor Taylor's "Principles and Practice of Medical Jurisprudence," or Dr. Guy's "Forensic Medicine."

JOHN DAY, M.D.

Geelong, Australia, April, 1879.

[From *La Nature*.]

THE CIRCULATION OF THE BLOOD.

By Th. Moureau.

As well known, the interior pressure of the blood in the arteries is the cause of the distention of the vessels, and also the reason why they appear hard when we press them with the finger. Since this pressure undergoes incessant variations, under the intermittent action of the heart, we might expect, when an artery is compressed, to find in it certain variations of hardness produced by the variations of internal pressure. This is, indeed, just what happens, and the pulse type of pulse that has been observed in man has been reproduced. By studying the matter in this way, some very curious results have been reached. It has been generally supposed that the strength of the pulse expresses the greater or less energy with which the heart sends the blood into the arteries, but experiments with artificial circulation show that the cause of these differences in pulse-force must be sought elsewhere. In fact, it oftenest resides very far from the heart, in the ramifications of the vessels.

When the arteriolæ and capillaries are obstructed, the pressure increases in the arteries; and the heart, even with all its normal force, can augment this pressure but very little; so

Fig. 1.—DIRECT SPHYGMOGRAPH.

of the arteries is due precisely to variations in the consistency of these vessels.

The true nature of the pulse was for a long time misunderstood, but the fact is well established at the present time that this phenomenon depends on neither the inflections nor displacements, nor even on the dilatation of the arteries, but on the changes in consistency that they experience through the effect of variations in pressure of the blood.

The sense of touch gives a very imperfect idea of arterial pulsation, and a better notion may be obtained by means of a curve made by a special apparatus. Let us compress an artery by means of a flexible spring, for instance; the constant pressure of this spring will be now sufficient, and now insufficient to depress the vessel. We will see, then, the the pulsations are feeble. On the contrary, when the dilated small vessels allow the blood to pass readily from the arteries into the veins, the arterial pressure decreases, as we have seen, and the heart's force, while it still remains the same, is capable of creating a greater variation in the pressure of the blood; so the pulsations are then strong.

There is another phenomenon to be noted, and this is an undulation of the descending phase of the curve. This undulation corresponds to a redoubling of the pulsation, which is at times perceptible to the touch in certain diseases, as typhoid fever for example, and which physicians call *dicrotism* of the pulse. Many theories have been put forth as to the cause of this phenomenon, and the artificial circulatory apparatus permits us to see under what conditions it is

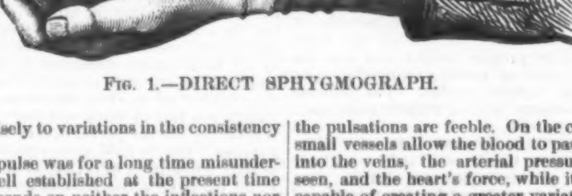


Fig. 2.—TRANSMITTING SPHYGMOGRAPH, FOR SENDING THE ARTERIAL PULSATION TO AN INSCRIBING LEVER PLACED AT A DISTANCE.

spring rise and fall by turns, now depressing the wall of the artery, and now raised by it. As this movement is so feeble that it cannot be readily perceived, we will increase it by means of a lever whose point will trace the curve of the pulse by the usual method. The instrument designed for this purpose is the *direct sphygmograph* (Fig. 1).

When the movement of the spring is transmitted by air to a lever placed at a distance, the instrument becomes a *transmitting sphygmograph* (Fig. 2), and this form of the apparatus will again be spoken of further on.

This means of demonstration, called the graphic method, shows that the pulse presents very varied forms (Fig. 3), and that the delicate character that it exhibits could not be accurately recognized by the most experienced touch.

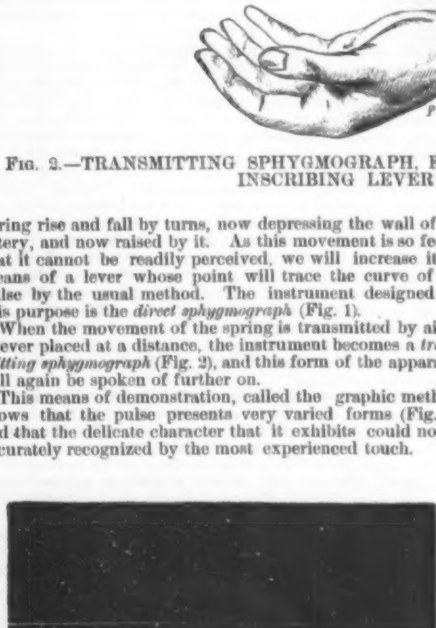


Fig. 3.—DIFFERENT TYPES OF PULSE.

To know with certainty the conditions that give rise to the different types of pulse, the best means is to reproduce them artificially, by changing the force of the heart, its time of action, and the frequency of its movements; and by causing the resistance of the capillaries, the caliber and elasticity of the blood vessels to vary, etc.

For this purpose, Prof. E. J. Marey has constructed various apparatus, which imitate all the hydraulic conditions of the circulation of the blood; and, by means of these, every produced. The *dicrotic* pulse is due to the fact that the blood, projected quickly, forms in arteries of a certain length, waves, so to speak, which follow one another from the center to the periphery and constitute a cause of elevation of pressure at the moment that they pass into the vessel. These waves are formed locally in the vessels where we observe them; they do not exist in the aorta, and their intensity and duration are at their maximum in the largest arteries. Finally, as the production of these waves requires a rapid propulsion of the blood, their existence supposes that the pressure is low in the arterial system, and that, as a consequence, the heart is easily emptied.

The undulating form of the pulse is reproduced in the apparatus of which we have spoken. We see it appear as soon as the arterial pressure is lowered to a certain degree. Every kind of pulse that the sphygmograph allows us to recognize in the healthy individual, or in sick persons, can also be reproduced artificially when the mechanical conditions of the heart's impulse, the elasticity of the arteries, or the permeability of the small vessels are imitated.

The sphygmograph translates, through the inflections of a graphic curve, the different phases of the pressure of blood in the arteries. It is, then, a sort of manometer: but with this difference, that while the mercurial manometer gives the absolute value of the pressure-variations that it expresses, the sphygmograph furnishes indications that are only relative.

Is it possible, then, to obtain from man those precise determinations that physiologists obtain from the lower animals by applying the manometer to their arteries? Yes, we shall see that the absolute value of blood-pressures can be obtained from the human being by means of this instrument when we apply it in a certain manner.

When we exert a certain degree of pressure on the skin, we observe that the compressed region becomes pale; this means that the blood has been driven from the vessels by an external pressure stronger than the internal pressure that caused it to penetrate these organs. Now, if we know what external pressure was necessary to overcome the pressure of the blood, we would have an absolute measure of the latter. We do this by immersing a member, or simply a finger, in a vessel filled with water and which we gradually compress, while a manometer indicates the degree of the counter pressure exercised on the tissues.

The arrangement of the experiment is shown in Fig. 4. A finger is inserted in glass tube, M, filled with water and firmly attached to a bracelet which surrounds the wrist. A pressure-valve prevents the liquid from flowing out around the finger. On compressing the liquid in the glass tube, by means of a small press, C, it is seen to gradually raise the column of mercury in the manometer. Now, this column is agitated by continual movements while the blood is entering the finger, and these movements are rhythmical, like those of the pulse, but they are observed to become weaker in proportion as the pressure rises. At length, when the counter pressure exceeds the blood pressure, the blood can no longer enter the finger, and the immobility of the mercury marks the corresponding degree at this stoppage. We thus obtain a measure of the manometric value of the blood pressure in the collateral arteries of the fingers. This value changes greatly according to the state of the circulation in health, and in diseases especially.

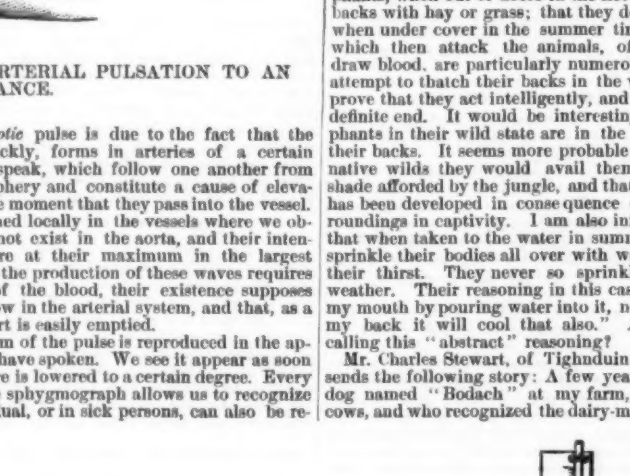


Fig. 4.—ARRANGEMENT FOR MEASURING THE BLOOD-PRESSURE IN MAN BY MEANS OF A MANOMETER.

INTELLECT IN BRUTES.

From several additional letters which we have received on this subject we select the following:

Mr. Claypole, of Antioch College, Ohio, writes: A friend of mine is employed on a farm near Toronto, Ontario, where a horse belonging to the wife of a farmer is never required to work, but is allowed to live the life of a gentleman for the following reason: Some years ago the lady above-mentioned fell off a plank bridge into a stream where the water was deep. The horse, which was feeding in a field close by, ran to the spot and held her up with his teeth till assistance arrived, thus probably saving her life. Was this reason or instinct? Again, a gentleman engaged in the business of distilling at Cincinnati has more than once told me that the rats in his distillery are in the habit of drinking any spirits spilt on the ground or left in open vessels, and that they often become, in consequence, so tipsy that they cannot run, and are easily taken by hand. Which is this?

Mr. J. J. Furniss, of New York, writes: Since the publication of my letter on the evidence of reasoning power in an elephant, afforded by the fact that he thatched his back with grass when exposed to the heat of the sun, I have received additional data bearing on the subject from Mr. W. A. Conklin, the superintendent of the Central Park Menagerie. I am informed by him that he has frequently observed elephants, when out of doors in the hot sunshine, thatch their backs with hay or grass; that they do so to a certain extent when under cover in the summer time, and when the flies which then attack the animals, often so fiercely as to draw blood, are particularly numerous; but that they never attempt to thatch their backs in the winter. This seems to prove that they act intelligently, and for the attainment of a definite end. It would be interesting to learn whether elephants in their wild state are in the habit of so thatching their backs. It seems more probable to suppose that in their native wilds they would avail themselves of the natural shade afforded by the jungle, and that the habit is one which has been developed in consequence of their changed surroundings in captivity. I am also informed by Mr. Conklin that when taken to the water in summer the elephants first sprinkle their bodies all over with water and then quench their thirst. They never so sprinkle themselves in cold weather. Their reasoning in this case seems to be: "I cool my mouth by pouring water into it, now if I pour water over my back it will cool that also." Am I not justified in calling this "abstract" reasoning?

Mr. Charles Stewart, of Tighnduin by Killin, Perthshire, sends the following story: A few years ago I kept a colly dog named "Bodach" at my farm, for herding the milk cows, and who recognized the dairy-maid as his mistress. On her directing him to keep the cows on a certain part of a field, he would lay himself down in the center of a line fixed by him as the proper limit. Patiently and vigilantly he would remain in quietness until any of the cows passed his limit, when he would swoop down on the trespasser, take her by the heels, and drive her back. It was wonderful in how short a time the cows came to recognize and respect the arrangement. He also came to know some of the cows by name. One of them named "Aggi" required at certain seasons to be milked oftener than the others, and the dairy-maid had only to say in Gaelic, "Bodach, go and bring home Aggi," when he would start for the pasture, single out Aggi, and bring her carefully home.

O. J. H. sends the following: An ordinary domestic cat

was equally fond of a friend of mine and of myself. As a test, we resolved to try the following experiment. We each held a piece of bread, of the same size, shape, etc., above the eyes of the animal. He looked at each hand and its contents alternately, attempting to solve the problem of getting at the bread without exhibiting partiality for either of his friends. He at last seemed to decide upon an expedient, for, raising himself upon his hind legs, he simultaneously seized a piece of bread in each of his front paws, and conveyed the food thus obtained to his mouth. On repeating the experiment after a lapse of some time, no difficulty was experienced in dealing with the matter, as the expedient just mentioned was resorted to without a moment's hesitation.

Prof. Nipher, of Washington University, St. Louis, U.S., writes: A friend of mine living at Iowa City, had a mule, whose ingenuity in getting into mischief was more than ordinarily remarkable. This animal had a great liking for the company of an oat-bin, and lost no opportunity, when the yard gate and barn door were open, to secure a mouthful of oats. Finally the mule was found in the barn in the morning, and for a long time it was impossible to discover how he had come there. This went on for some time, until the animal was "caught in the act." It was found that he had learned how to open the gate, reaching over the fence to lift the latch, and then he effectually mystified his masters, by turning round, and backing against it, until it was latched. He then proceeded to the barn door, and pulling out the pin which held the door, it swung open of its own accord. From the intelligence which this animal displayed on many occasions, I am of opinion that had not discovery of his trick prevented, it would soon have occurred to him to retrace his steps before daylight, in order to avoid the clubbing which the stable boys gave him in the morning. It may be added that this animal had enjoyed no unusual educational advantages, and his owners found it to their interest to discourage his intellectual efforts as much as possible.

The Rev. George Henslow endeavors to sum up as follows from the stories that have already appeared: I am quite ready to admit that more than one instance (notably Dr. Frost's cat, which spread crumbs to catch birds, and which is paralleled by one mentioned in Wood's "Natural History," which "chirped" like a sparrow, and so enticed and caught them), if correctly stated, and if the motive of the animals could in every case be proved, will completely overthrow any supposition that animals never copy us with the same or a rational purpose. I cannot help thinking, however, that such cases are very rare. Moreover, I will abandon my notion of abstract reasoning, at least, as hitherto described, for I now think that what I meant by the want of the faculty would be better described as an impotence, or, at least, a feebleness of mind in concatenating correlative ideas; or, perhaps, a want of a receptivity of the suggestiveness of things will express my meaning. On the other hand, I still see no reason for believing that animals can conceive of a purely abstract idea. Thus, "V. I." says a mule would turn on a tap, but did not turn it off again. The reason I would suggest is that wastefulness being an abstract conception, the mule could not entertain it. If this be correct, we may now proceed a step further. The idea of a personal *Ego* is purely abstract; hence I am led to believe that no animals can be self-conscious, and as a direct consequence, they cannot be either moral or immoral, but are simply automata and non-moral. Like children, they can learn by being scolded, when they displease their master, so that a conscience similar to a child's can be produced in them; yet they cannot naturally be moral. Thus, *e.g.*, self-interest is all in all with animals, but it can never lapse into selfishness, which is the conscious abuse of self-interest. We "punish" a dog, but we never look upon it as a criminal. So, too, no animal can ever act unjustly towards another, because it cannot be conscious either of justice or injustice. The abstract conceptions of righteousness and justice are only applicable to acts done under a sense of righteousness and justice. The same remark applies to personal immoralities; so that no animal can be immoral. That animals cannot entertain abstract ideas is not at all surprising, seeing how slow children are to do the same. A somewhat grotesque illustration will show this. A class of boys was asked what conscience was. None could explain it, so the teacher defined it as "something within you that tells you when you have done wrong." A boy at once exclaimed it was a stomach-ache. On inquiry it turned out that he had stolen and eaten some unripe fruit, and doubtless felt the remorse of conscience accordingly! If, then, my former position be qualified, I would restate it as corrected by the cases recorded as follows: Animals reason as we do, but always in connection with concrete phenomena, whether immediately apprehended by the senses, or present to consciousness through memory; but like children they are slow to perceive the suggestiveness of things. They have, moreover, no power of conceiving truly abstract ideas. Hence they cannot be self-conscious, cannot conceive of God, and can neither be moral nor immoral, but are simply non-moral automata. On the other hand, that which rescues man from being an automaton pure and simple, is his power of conceiving of abstract ideas, which enables him to be self-conscious; consequently he can conceive of a personal, *i.e.* self-conscious Deity, so that he at once becomes a responsible being, and can be positively moral or immoral.—*Nature.*

A VALUABLE INSECT.

It is stated that an American explorer has recently discovered in the little-known district of Yucatan bordering on British Honduras, a valuable insect, possessing properties which ought to make it a rival of the cochineal and shellac-producing insects. This is the *neen*, or *niin*, a species of *Coccus*, which feeds on the mango tree and similar plants, and exists in enormous quantities in Central America. It is of considerable size, of a yellowish brown color, and emits a peculiar oily odor, containing as it does a large quantity of fatty oil, or rather grease. This grease is used by the natives for various purposes, being highly prized as a medicinal oil for external application, and it is also employed for mixing paints. It can be made to change its condition very considerably by different processes. When exposed to great heat, the lighter oils evaporate, leaving a tough flexible mass resembling half-softened wax, but unaffected by heat or cold, which may be used as a lacquer or varnish. When burnt, this material produces a thick semi-fluid mass, somewhat resembling a solution of India rubber, which, after a few days, becomes hard and solid. As a cement this substance will be invaluable, and it might also be used for waterproofing purposes.

The Ottawa *Citizen* says that fishing in Canadian waters has been carried on so recklessly that there is now considerable anxiety as to future supplies.

THE DESMAN.

The desman is the most interesting species of the order of *insectivora* as represented in the Pyrenees. It is very singular that so remarkable an animal as this should have remained unknown to naturalists up to the year 1825, when M. Rouais, of Tarbes, brought it to the notice of Geoffroy. Almost at the same time it was detected at Saint-Laurent de Cerdans by Dr. Companyo.

The desman is a sort of large aquatic shrew, but differs from the shrew proper in having two very small teeth between the two great incisors of the lower jaw, and in their two upper triangular and flattened incisors. Their muzzle extends into a long and flexible proboscis, formed of two united tubes, and representing the nostrils. This proboscis is provided with special muscles which permit the animal to move it in all directions, and it also constitutes an organ of touch almost like the trunk of an elephant, its sensitiveness being increased by the long silky hair with which it is provided. Still another peculiarity to be noted is the presence at the base of the tail of an odoriferous gland, which emits a strong musky smell. This odor is so lasting that it is even perceptible in specimens that have been mounted for several years. The desman of the Pyrenees is from six to eight inches in length, and its tail is about half as long as its body. Its fur is chestnut-colored along the back, grayish-brown on the sides, and silvery along the belly. The extremities of the hairs, especially those of the back, are iridescent as in the golden-green moles of Africa. This iridescence is especially noticeable in specimens preserved in alcohol.

THE DESMAN.

The feet of the desman are webbed, and the animal is aquatic in its habits, like the otter. It lives in deep burrows excavated in steep banks along mountain streams, and, leaving its dwelling only during the night, it is scarcely ever captured except by accident. There are, however, several means of taking the animal; one of these is by traps baited with large living insects; another, and still better method, is by carefully visiting stacks of newly-cut hay, under which it is not rare to find one of the animals that has been surprised in its nocturnal hunting by the rising sun.

This animal inhabits all the valleys of the Pyrenees, but is everywhere rare. Several species are found in Southern Russia, and recently M. Graëlls, of the Museum of Madrid, has detected one in Spain.

THE STEAM YACHT WANDERER.

This vessel has been built for Mr. C. J. Lambert, of Park-lane, who proposes to emulate Mr. Brassey and the Sunbeam, and make a voyage round the world. The trial trip of the Wanderer took place May 15th, the ship running down the Firth of Clyde. The Wanderer was built by Messrs. Robert Steele & Co., of Greenock, and is of the following dimensions: Length of keel and forerake, 175 ft.; breadth, 29 ft.; depth of hold, 16 ft. 3 in.; draught of water forward, 12 ft. 9 in.; draught of water aft, 14 ft. 9 in.; tonnage, builder's measurement, 705 tons. She is built on the composite principle, in accordance with the rules of Lloyd's Registry for a vessel of the fourteen years class, and she is classed for twenty years by the Liverpool Underwriters' Association. She is rigged as a three-masted schooner, and her spread of canvas is 18,000 square feet, her main lower masthead being 92 ft. above deck. One of the principal objects aimed at in designing this yacht was, that in addition to her being a full-powered steamer, she should also be thoroughly efficient as a sailing vessel. Every appliance has been adopted on board for the expeditious working of the gear. She has one of Harfield's patent steam windlasses, having a winch in connection with it for the working of the principal sails, or for the purpose of warping the vessel. Small hand winches are also attached to each mast. As the ship may find her way into regions where the supremacy of the British flag is not recognized, the yacht is well armed. On deck she carries five Armstrong 7-pounder steel rifled pivot guns on teak carriages, working on gun metal segments. There are also fixed on the rail aft two Nordenfeldt guns, capable of firing 500 shots per minute. The armory is below, in the main cabin passage, and is fitted for one dozen Henry-Martini rifles, one dozen Soper rifles, with swords or bayonets suitable for each; two dozen revolvers, and one dozen boarding pikes. The whole of the deck fittings, which will be finished in white and gold, are of teak, including three large deck houses, the foremost of which covers over the forward staircase, and contains the owner's deck cabin, captain's room, and chart house; the midship house covers the engine room; the aftermost contains after-staircase and smoking room. All the deck cabins are fitted up in a very handsome manner in maple and wainscot, the furniture being of Italian walnut. The whole of the brass work on deck, including binnacles, telegraphs, etc., as well as the fittings inside the deck house is electro-plated. The lower deck, fore and aft, is occupied with the necessary accommodation for owner, officers, and crew. The crew, numbering about thirty, are berthed in the forecastle close forward; abaft this is the galley, bakery, etc., for the owner and officers. From the galley to the forward engine-room bulkhead, is arranged for the accommodation of officers, petty officers, and servants, including state rooms for chaplain, doctor, and artist; also separate mess rooms for officers, petty officers, and servants, with pantries, etc. The engine and boiler space, including bunkers for 120 tons of coal, is about 45 ft. in length. The owner's apartments are all abaft the engine-room, and connected with the fore part of the vessel by a side passage about 7½ ft. high by 3 ft. wide. The principal state-rooms are fitted up in bird's-eye maple, with furniture of Italian walnut. The sides of the corridors are all of oak. In addition to one general bath-room in the afterpart of the yacht, each of the state-rooms has a bath under the floor supplied direct from the sea. The main saloon—which is beautifully finished in hard wood—is placed abaft the state-rooms, and is somewhat oval in form, the panels being bird's eye maple and relieved by Hungarian ash stiles, mouldings, etc. The sideboards, tables, chairs, and all other pieces of furniture, are of walnut. The fireplace, which is placed at the fore-end of saloon, is of carved walnut, and has a very handsome grate in it, and above is placed a handsome mirror in carved walnut frame. The tables are all made on the swinging principle, those for dining being placed on the port side of saloon, while the other side is occupied by writing and reading tables. Electric bells are fitted throughout the vessel. The cushions in the saloon and all the principal state-rooms and deck-houses are upholstered in green morocco leather. Abaft the saloon are a number of store-rooms, linen-lockers, etc. The hold of the vessel is all occupied by store-rooms, comprising chain-lockers, carpenter's and boatswain's store-rooms, sail-rooms, engineers' store-room, lamp and oil rooms, steward's store-room, ice house, fresh water tanks, wine cellar fitted up with bins; also, powder-magazine, baggage-rooms, etc. The yacht is fitted by the Perkins Engine Company, London, with engines and boilers on the Perkins system. There are three cylinders, having diameters of 17 in., 34 in., and 48 in. respectively, and a stroke of 30 in.; only two cranks being required as in the ordinary engines. The working pressure is usually 400 lb. per square inch, the safety valves are loaded to 500 lb., and the power realized is 800 indicated horse-power, with a total weight of machinery of 130 tons. The ship cruised round Holy Island, and returned to Gourock bay about 6 P. M. According to the Glasgow *Herald*, to which journal we are indebted for much of the preceding information, a speed of about 11½ knots was attained under easy steam. According to the same authority, the consumption of fuel was stated to be 1·25 lb. of coal per horse per hour, but we have no particulars as to the way in which these figures were arrived at.

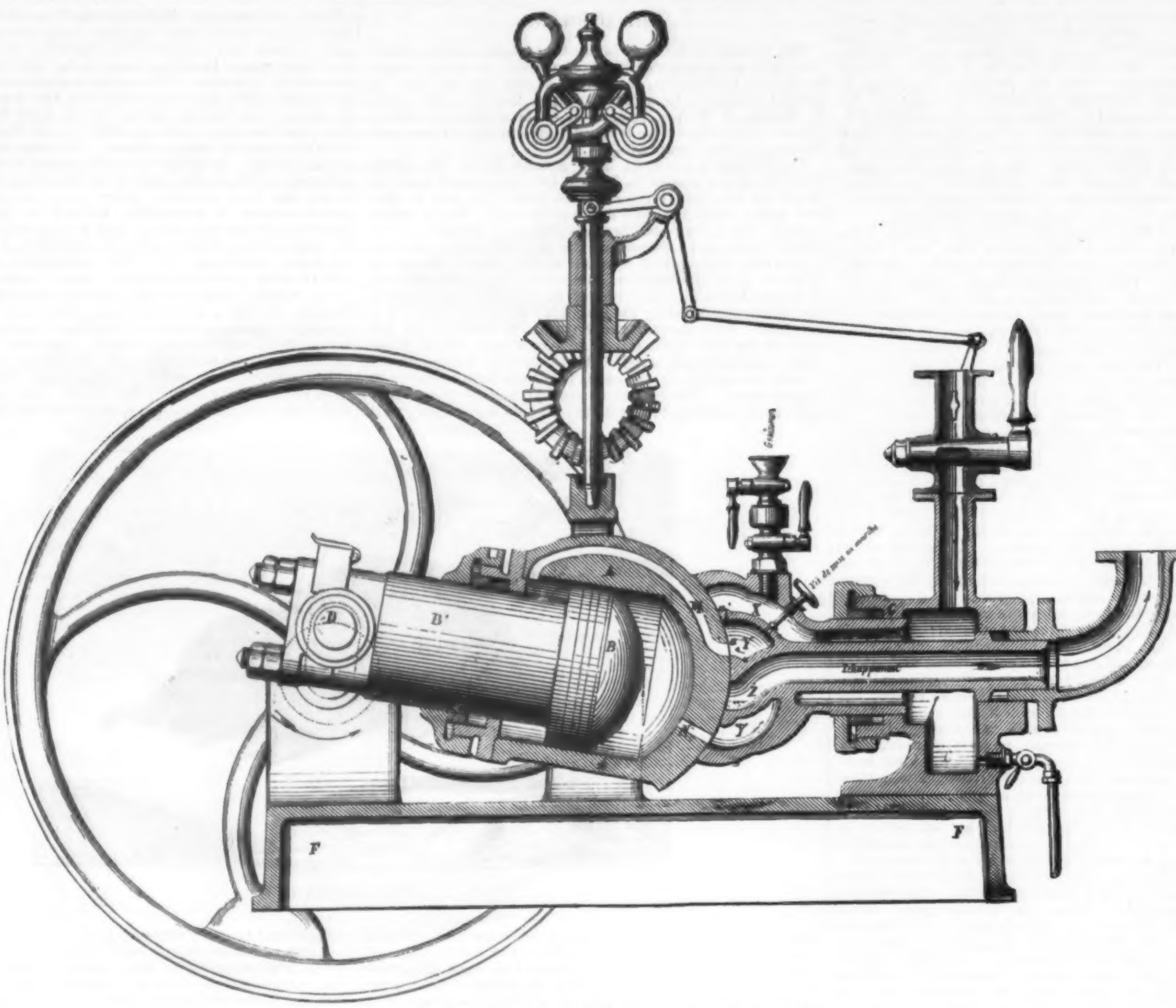
HOW MUCH WILL A LOCOMOTIVE PULL?

There is probably no question which a railroad engineer is obliged to answer oftener than this, and, although the calculation required to give a reply is not a difficult one, yet to most of those who are not engineers it seems very abstruse. It has seemed, therefore, that an article on this subject for persons who, as regards the profession of engineering, are laymen or juniors, might not be without interest or value. To members of that profession notice is given that the article will probably not contain any information which will be new to them, or that is not found in the text books and treatises on locomotives.

It may be stated, generally, that the means by which a locomotive exerts its power in drawing trains is simply the friction or adhesion of the driving wheels on the rails. Or, to quote from Pambour's old "Treatise on Locomotive Engines:" "Two conditions are necessary in order that an engine may draw a given load: First, that the dimensions and proportions of the engine and its boiler enable it to produce on the piston, by means of the steam, the necessary pressure, which constitutes what is properly termed the power of the engine; and second, that the weight of the engine be such as to give a sufficient adhesion to the wheel on the rail. These two conditions of power and weight must be in concordance with each other; for, if there is a great power of steam and little adhesion, the latter will limit the effect of the engine, and there will be steam lost; if, on the other hand, there is too much weight for the steam, that weight will be a useless burden, the limit of the load being in that case marked by the steam."

In the early days of locomotives it was thought that the friction or adhesion of the driving wheels on the rails would not be sufficient to enable such machines to exert their full power; and many contrivances of toothed wheels and mechanical legs of various kinds were devised and experimented with. Even when Wood's "Treatise on Railroads"* was written, the author spoke of adhesion, exclusive of the power requisite to drive the engine itself, in the best or modern engines, as equal to the one-fifteenth part of the insistent weight; and of the common engines, working with vertical cylinders, as equal to the twentieth part of the weight, pressing on the rails by the driving wheels." Pambour (page 252) gives the maximum adhesion at one-sixth of the weight, but says "the force of adhesion is always at least one twentieth of the adhering weight." In Rankine's "Treatise on the Steam Engine" (page 529), he gives

* Third edition, 1838, page 477.



IMPROVED OSCILLATING ENGINE.

the adhesion at from one-twentieth to one-fifth, and adds that one-tenth may be considered an average ordinary value."

Perhaps the figures which are most used in practice are those published in Molesworth's "Pocket Book of Engineering Formulæ," page 124. These are as follows:

ADHESION PER TON OF 2,240 LB. ON THE DRIVING WHEELS.

When the rails are very dry........	600 lb. per ton.
When the rails are very wet	550 " " "
In ordinary English weather....	450 " " "
In misty weather, if the rails are greasy......	300 " " "
In frosty or snowy weather...................	200 " " "

In D. K. Clark's "Manual for Mechanical Engineers," page 724, he gives a report of experiments made by M. Poirée on the Paris and Lyons Railroad with a wagon by skidding the wheels. Of these experiments Clark says:

'At speeds under 30 miles per hour it appears from the table that, when the rails are dry, the co-efficient of friction, or the adhesion, is one-fifth of the weight, and that on very dry rails it is one-fourth. As the speed is increased, the adhesion is reduced. These data are corroborative of the results of the author's experiments on the ultimate tractive force of locomotives on dry rails, from which he obtained a co-efficient of friction equal to one fifth of the weight, at speeds of about 10 miles per hour."

It will thus be seen that the co-efficient of adhesion, as given by these authorities, varies all the way from one-twentieth to over one-third. It is no wonder then that a young engineer in taking up this subject should be a little perplexed to know what data to take in making his calculations. Even if he leaves out the maximum and minimum and takes what these authorities regard as "an average ordinary value," he will be still very much perplexed. Thus Wood gives $\frac{1}{15}$, Rankine $\frac{1}{16}$, Molesworth and Clark $\frac{1}{4}$. In fact, the differences are so great that we are led to believe that some or all of these writers must have been quite mistaken in their facts or their theories on the subject. Recent experiments have made it plain that such was the case.

In reading what these writers have written on this subject, it is nowhere apparent that they made any distinction between sliding and rolling friction, or static and dynamic adhesion. Now every locomotive runner knows that after an engine begins to slip its wheels it will not exert as much power as it will before they begin to slip. In other words the adhesion of the wheels is much less when they slip than when they roll without slipping. Now most of the experiments which have been made to determine the adhesion of driving wheels have given the sliding friction of the wheels on the rails and not their adhesion when they roll and do not slip. The first is dynamic and the last static friction.

Fortunately the experiments of Mr. Westinghouse and Captain Galton have thrown a great deal of light on this subject, and they have shown in the most conclusive way not only the great difference between these two kinds of friction, but also that the one, at least, is very much affected by the speed and also by the time. That is, they have shown that at a high speed the friction is much less than at a low one, and that it is considerably less after some seconds than it was at the beginning. This confirms the ordinary every day experience of locomotive runners. The fact that until recently the distinction between these two kinds of friction has not been recognized is doubtless the reason for the great discrepancies in the data relating to this subject.

In the paper "On the Effect of Brakes upon Railway Trains," read by Captain Galton before the Institution of Mechanical Engineers,* the following determinations of the adhesion of wheels are given. It must be kept in mind, too, that he makes the distinction between "adhesive" and sliding friction. By "adhesive" is meant the friction between rolling wheels and the track.

"On dry rails it was found that the co-efficient of adhesion of the wheels was generally over 0·20. In some cases it rose to 0·25 or even higher. On wet or greasy rails, without sand, it fell as low as 0·15 in an experiment, but averaged about 0·18. With the use of sand on wet rails it was above 0·20 at all times; and when the sand was applied at the moment of starting, so that the wind of the rotating wheels did not blow it away, it rose up to 0·35 and even above 0·40."

This is probably the most correct determination of the adhesion of wheels that has ever been made, and shows that the ordinary rule of taking the adhesion at one-fifth of the weight in the driving wheels is quite within the limits of ordinary practice. Even on a wet or greasy rail, with the use of sand, it was above 0·20 at all times. In fact, if we want to calculate the maximum power which a locomotive will exert if the rails are sanded, we might take the adhesion at one-third, and would be quite safe at one-fourth.

In order to put these figures in a form in which they can easily be remembered and conveniently used, they may be given as follows:

ADHESION OF LOCOMOTIVES.

Under ordinary conditions, without using sand on the rails, or on wet, sanded rails....	One-fifth the weight on the driving-wheels.
Under favorable conditions, without sand	One-fourth the weight on the driving-wheels.
On a dry, sanded rail.......	One-third the weight on the driving-wheels.

These may be taken as working data, but before we can apply them and answer the question which forms the title of this article it must be known how much power is required to draw a given load over a road with known grades and curves. If the authorities be consulted with reference to this point a wider difference even than that relating to the adhesion of driving wheels will be found to exist. Without comparing these, it may be stated that the most recent experiments have shown that the resistance of good American cars does not exceed 6 lb. per ton of 2,000 lb. at very slow speeds on a straight and level track, and when in the best condition and good weather it is probably not over 4 lb. The wind, however, has an important influence, and as this is very variable it is hardly safe to take the resistance under the conditions named above at less than 6 lb. per ton.

With reference to the influence of speed on the resistance, it must be admitted that our knowledge is very inexact, and probably the law or laws which govern it are not understood. The following rule, though, will give results which do not differ materially from those given by the most reliable experiments which have thus far been made.

* See *Engineering* of May 2, 1879, page 371.

To get the resistance per ton (of 2,000 lb.) of a train on a straight and level track at any given speed: Square the speed in miles per hour and divide by 170 and add 6.

To get the resistance per ton due to any grade. Multiply the rise in feet per mile by 0·3815, and add the quotient to the resistance due to the speed on a straight and level track.

Our knowledge of the resistance due to curves, like that due to speed, is in a very unsatisfactory condition, but the most reliable information we have indicates that the resistance is equal to about half a pound per ton per degree of curvature.

We may then tabulate these calculations as follows:

RESISTANCE OF TRAINS.

On straight and level track at very low speeds..............	6 lb. per ton of 2,000 lb.		
For resistance due to speed: Square the velocity in miles per hour and divide by 172...	.. lb.	"	"
For resistance due to grade: Multiply the rise in feet per mile by 0·3815....................	.. lb.	"	"
For resistance due to curves: Add ½ lb. per degree of curvature.....	. lb.	"	"
Total.......	.. lb.	"	"

If the radius of the curve is given, the "degree" may be found approximately by dividing the radius into 5,730. This rule is correct enough for ordinary curves of over 500 feet radius.

Having these data, suppose we want to calculate how much, say, a Consolidation engine will pull up a grade of 70 feet per mile, with 9° curves and at a speed of 20 miles per hour. The first question to determine will be whether we want to know the maximum load which such an engine will draw, or what it will do in good weather, or what it will do at all times. In the first case we would take the adhesion at $\frac{1}{5}$ the weight on the driving wheels; in the second at $\frac{1}{4}$, and in the last case at $\frac{1}{3}$. We will assume that the second represents our hypothetical case, and that the locomotive has a weight of 11,000 lb. on each driving wheel, or a total of 88,000 lb. The adhesion would therefore be one-fourth of 88,000 lb. = 22,000 lb. The train resistance per ton would be as follows:

Resistance on straight and level track = 6·0 lb.

" due to speed $= \frac{20 \times 20}{172} =$ 2·3 "

" " " grade $= 70 \times 0{\cdot}3815 =$ 26·7 "

" " " curve $= 9 \times \frac{1}{2} =$ 4·5 "

Total 39·5 "

Therefore, as each ton will have a resistance of 39·5 lb., and as our engine is capable of exerting a tractive force of 22,000 lb., the total load which it can pull would be represented by

$$\frac{22{,}000}{39{\cdot}5} = 556{\cdot}8 \text{ tons.}$$

As the engine and tender weigh about 72 tons, the train which our engine will pull will be represented by 556·8—72

=484·8 tons, which is equal to about 24 loaded cars. Of course, to do this work the cylinders must be large enough to turn the wheels, and the boiler have the requisite capacity to supply steam.

For the calculation of the size of the cylinders, there is only room here to give a simple rule, which is only approximately correct, but near enough for ordinary purposes. This is: Multiply the total weight on the driving wheels in tons (of 2,000 lb.) by their diameter in inches: then four times the product will be the cubical capacity of one cylinder, or rather of the space swept through by the piston during a half revolution of the wheels. Having the cubical contents of the cylinder the diameter can readily be found from the stroke or the stroke from the diameter.—*Railroad Gazette.*

IMPROVED OSCILLATING ENGINE.

By FOURNIER & LEVET, Mechanical Constructors, Genelard, Saone et Loire.

THIS machine, p. 2928, distinguishes itself from all others by its construction and by the special mode of distribution.

It is somewhat similar to the oscillating engine, but differs in the essential manner of the distribution, for instead of being performed in the pivots, or in an apparatus placed on the axis of oscillation, it is accomplished in the rear of the cylinder itself. For this purpose the rear of the cylinder is circular, and rests on two steel pivots, which support it. Two openings, M and N, communicate with the cylinder, the one with the front, the other with the rear. The piston has a cylindrical form, and is provided with a packing formed of two Swedish segments. The trunk, B', is cast on to the same, and with it passes into a large stuffing box contained in the outside covering of the cylinder. The steam-chest, which also forms the slide valves, is provided with three channels: X communicates with the boiler; the other, Z, is for the escape of the steam; and the third, YY, establish, at a certain moment, the connection with the front and rear of the cylinder.

This entire steam chest glides in a stuffing box so that the pressure of the steam is always applied to the rear of the cylinder and insures a close and tight fitting joint. If we examine the different stages of the distribution during an entire motion, we will find two well-defined and distinct operations. During the first operation the passage, M, opens, and the point, *a*, is found to be opposite, *a'*, and the steam passes to the front of the piston, and until the middle of the course this opening gradually opens more and more; then it closes itself during the second movement of this course, and is completely closed by the part, *a'b'*, when the piston arrives at the rear of the cylinder. During this time the rear part of the cylinder has communicated with the escape channel. The oscillation continues, the passages, M and N, commence to be uncovered, and are placed in communication by means of the channels, YY. The rear surface of the piston being much larger than the front surface, the piston is pushed forward and the steam expands during this period in a degree that is proportional to the two surfaces. Live steam is used during the passage from the front to the rear, but during the passage from the rear to the front the same steam that was used for the first passage is used again, and now presses against the much larger rear surface of the piston. In order to start the machine, a screw permits of a communication being formed between X and Y, so that the steam can act in whatever position the piston may be. This ingenious disposition makes use of the Woolf system in a machine having only one cylinder. It permits of constructing the machine in a very simple manner and of a great reduction in the price of the same.—*Annales Industrielles.*

SONOMETRY BY ELECTRICAL INDUCTION.

THEIR Royal Highnesses the Prince and Princess of Wales, the Marquis and Marchioness of Salisbury, Lord Rayleigh, Sir John Lubbock, and other distinguished guests, recently visited the house of Mr. W. Spottiswoode, President of the Royal Society, to examine the loud-speaking telephone of Professor Edison, who is at present represented in this country by Mr. Arnold White. The telephone, under the supervision of Mr. Conrad W. Cooke, worked admirably, and by its loudness and distinctness justified its right to the name it bears. We believe, however, that new instruments, embodying important improvements, are on their way to this country.

In addition to the Edison telephone, the Cowper writing telegraph was shown, and two very beautiful instruments by Professor D. E. Hughes, which also formed the subject of a paper read by that gentleman before the Royal Society lately.

A short time since we described at considerable length the valuable investigations of Mr. Hughes, which had for their object the elimination of the effects of induction upon telegraph lines, and we illustrated on the same occasion the apparatus he designed to effect this, and which, as we pointed out, completely and most efficiently answered its purpose, not only in reference to one pair, but for any number of lines in a group.

It will be remembered that the function of the apparatus is to generate, at the same moment that a current is passed through a primary wire, a current of equal strength, but of opposite direction to that induced by the one passing through the primary wire, so as to neutralize exactly the induced current, and to free the wire from its objectionable influence. The means by which this is effected are, as will be remembered, of the simplest possible character. They consist of a compensator formed of coils of wire, the lengths of which are proportional to the lengths of the lines to be protected. There are as many of these coils as there are lines, and they are mounted on a cylinder in such a way, that the distance between them can be regulated as may be found necessary. This compensator is joined to the lines at the transmitting end, and once adjusted, need not be again changed. The correctness of the adjustment is determined by having, in circuit with the line, a battery and clock-microphone and a telephone in connection with the induction rings. By means of the telephone, the ticking of the clock on the microphone circuit can be heard, until by sliding backwards and forwards, the position is attained when the induction current is exactly balanced by the reverse currents in the coils, and absolute silence ensues. The other important part of the apparatus is that for reversing the current in the coil of the primary wire at the moment of passing a current through the latter, so that the induction thereby set up in the adjoining coil and wire may be neutralized.

Two distinct and very beautiful applications of this induction balance have since suggested themselves to Professor Hughes, and, as stated above, were exhibited to H.R.H. the Prince of Wales. We will briefly describe the principles upon which these apparatus are designed, and we must refer to some of the well-known experiments made use of by Professor Hughes during his investigations which led up to the induction balance. In our article on the subject already referred to, we published a diagram of the arrangement employed by Professor Hughes to illustrate the power of induction. He employed two insulated coils, one of which had a telephone in circuit, and the other a clock-microphone and battery. The influence of induction is strikingly illustrated by this simple apparatus. So long as the two coils are kept parallel to each other, the ticking of the clock can be heard clearly, thanks to the delicate recording power of the telephone, even when the coils are separated by a distance of 2 feet or 3 feet, the sounds becoming, of course, louder as the coils are brought closer. This simple experiment illustrates clearly the principle on which the first of the two new applications of the induction balance is based. Professor Hughes calls it the sonometer or audiometer, and it is intended for conducting aural investigation with absolute accuracy, a line of inquiry hitherto limited, for the want of such an instrument. It is represented by the accompanying Fig. 1, and consists of a small bedplate with a bracket at each end to carry a horizontal rod 200 millimeters in length, and of the section shown. At one end of this rod is fixed a bobbin, A, with 100 meters of insulated wire wound upon it, and at the other is a similar but smaller bobbin, C, upon which is wound about one meter of insulated wire. These coils are so connected together as to have opposite (but necessarily unequal) inductive influences upon a third bobbin, B, sliding between them. They are placed in circuit, with a battery, a galvanometer, and a clock-microphone. Sliding on the rod is the third bobbin, B, carrying 100 meters of wire, in every respect similar to the bobbin, A, and having a telephone in circuit with it. It will be seen at once that induction will make the clock audible by means of the telephone, but with varying loudness, according to its relative distances from the bobbins, A and C; also, it will be seen that there exists a point on the rod where the induction from C will be equal to, and entirely neutralize that from A, and absolute silence must ensue, and it will be evident that this zero point is nearer to C than A, on account of the difference in the power of the coils, for if both were equal the zero point would be equidistant between them. The only object in making A and C of different proportions is to insure a longer range or scale. The rod is divided into centimeters or any other convenient units. The action of the instrument will now be at once evident. To test the aural power of any person it is only necessary to place the telephone coil against the bobbin, A, and slide it slowly towards zero, until the point is reached when the ticking of the clock becomes inaudible, the scale on the rod then indicates exactly the aural power, which can be thus denominated by a number, the value of which may be fixed to any convenient standard. We believe that the most delicate sense of hearing yet tested with this instrument does not descend nearer than five millimeters from the zero point, whilst the average power varies between 10 and 20. The scientific as well as the physiological uses of this simple instrument will probably be very great.

The second application of Professor Hughes' balance is represented by Fig. 2. In this a different principle is employed, for whereas in the audiometer one coil is shifted to and fro until perfect equilibrium is attained, in this one, a perfect electrical balance is permanently established, and upon its accuracy the delicacy of the instrument depends. It consists, as will be seen, of two hollow cylindrical boxes, around each of which are wound two parallel coils. One pair of these is connected by a line, and is placed in circuit with a battery and clock-microphone. The other pair is also connected with a wire, and joined in a telephone circuit. The induction set up in the secondary line from the current passing through the primary coil is balanced by the reversal of one of the bottom coils, and adjusted to an absolute silence point. The distance between the two boxes is immaterial, in fact, they may be miles apart, or standing on the same table. Now, if any metallic substance, a coin for example, be placed in one of the boxes, the balance is destroyed by the resistance set up in the body of the metallic substance introduced, and the ticking becomes audible, and so delicate can the adjustment be made, that if two coins, similar, but not absolutely identical in weight or composition, be introduced, the difference can be at once detected by the sound. Thus, if a couple of sovereigns fresh from the Mint be placed one in each box, the balance is not upset; but if one of these coins be subjected to a very slight degree of attrition, the balance is destroyed and the ticking of the clock becomes audible. In this way the existence of impurities in metals, or of inequalities in alloys, too minute to be discovered by analysis, are instantly detected, while perfect similarity is also as instantly proved. Some very interesting investigations with an instrument embodying this principle have been carried out recently at the Mint by Mr. Chandler Roberts.

From this brief description it will be seen that the value of the Hughes induction balance is not confined to telegraphic uses, but has wide and varied applications, two of which have thus been indicated by Professor Hughes himself, who has thereby placed in the hands of the scientific world the means of obtaining an electrical balance as absolute in precision as it is simple in principle and construction.—*Engineering.*

FIG. 1.

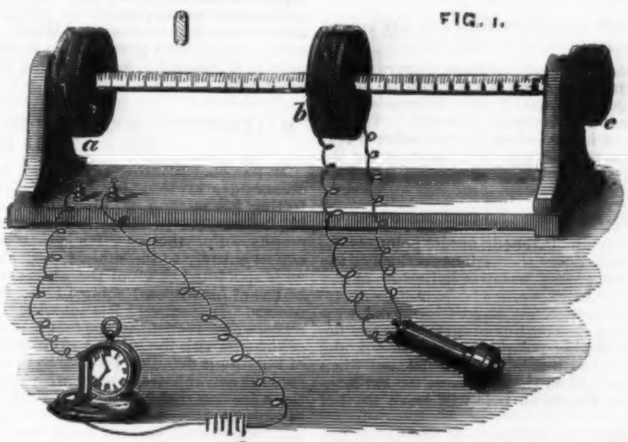
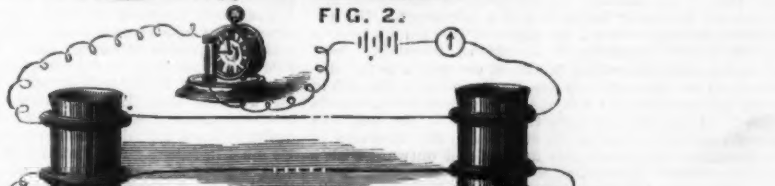


FIG. 2.



PROFESSOR HUGHES' INDUCTION BALANCE.

ON SPIRALITY OF THE ENERGY IN BAR MAGNETS.

By R. C. SHETTLE, M.D.

1. THE very extensive field of research as to the cause of magnetic and diamagnetic phenomena has been brought within the compass of a brief paper by a new method of investigation and the discovery of the law regulating the force upon which the phenomena depend.

2. The method consists in an examination of the lines of force in bar magnets of low power, by means of test magnets made from the points of the finest needles; such test magnets being suspended with the greatest delicacy.

3. The great superiority these needles thus suspended possess as methods of research must be obvious—

First.—From the fact that the lines of magnetic force are always projected in lines of greater or lesser curvature, and,

Second.—From their extreme lightness and delicacy of suspension they are capable of being moved by magnetic force of very low power.

It has been ascertained—

1. That the equator of a bar magnet is oblique and decentered.

2. That the impulses of energy or force pass from the equatorial direction toward the pole ends in oblique lines.

3. That similar impulses of energy or force pass from the pole ends toward the equator.

4. That the momenta or impulses of energy meet at a given point which is called for convenience of description the crucial line, that they then collide and are ejected in parallel lines from the side of the pole at such point.

5. That the energy which passes from the equator toward the crucial line, for convenience of description is considered as that primarily induced; or the action which is developed by external force, the direction and energy of which action must correspond with the direction and energy of such external force.

6. That the energy which passes from the pole end toward the crucial line is—also for convenience of description—considered as secondary; or as the reaction, which according to Newton's third law of motion is always equal and opposite to action.

7. That this reaction takes place within the pole end in proportion to the capacity the body operated upon offers for force.

8. That the power of exhibiting magnetic phenomena is due, and in proportion, to the energy with which these lines of force collide as they emerge from the bar.

9. That the momenta or impulses from either direction are oblique and characterized by leverage, which leverage results from the resistance to velocity which the two forces—action and reaction—mutually exert at the colliding line.

10. That this leverage increases from either direction toward the crucial line; and, consequently, the needle points resting on the magnet, and which are indices of the direction and degree of force, gradually become less oblique, until at the crucial line they take a direction at right angles to the axis of the bar.

11. That the needles acquire a perfectly vertical direction

when situated over a point where such impulses from all directions meet at a common center.

12. That an inclined plane and a lever which are thus found to exist combined in all magnetic force is essentially characteristic of screw or helical motion.

13. That magnetic attraction is due absolutely to two helices of force of similar extension working into each other from opposite directions.

14. That magnetic repulsion is due to two helices of force of dissimilar extension working against each other from opposite directions, precisely in the same way as the momenta or impulses of energy from two opposite directions meet at the crucial line.

15. That the iron filings test, when two dissimilar poles are opposed, can be explained, and explained only, on the assumption that two similar helices of force are thus working into each other from opposite directions.

16. That the iron filings test, when two similar poles are opposed, is characteristic of two dissimilar helices of force from opposite directions mutually repelling each other, just as at the crucial line.

17. That this hypothesis with regard to the cause of the various positions of the needle at the crucial line has been determined by 210 observations.

18. That these observations consisted in placing one of the magnetic needle points on every portion of every surface of the pole end of one bar magnet, and then subjecting it to the influence of every structure of a similar pole of another magnet; when it was found that upon the two poles touching, the needle took the same position along the line of junction of the bars, as along the crucial line of either bar.

19. That in taking such positions as the one bar was approached to the other, four descriptions of movements of the test magnets occurred—

First.—Directly upward and backward when placed on the median line.

Second.—A wheeling to the right upward when placed on the right of the median line.

Third.—A wheeling to the left upward when placed on the left of the median line; and

Fourth.—A movement directly outward when placed on the edge of the stationary bar within $\frac{1}{8}$ of an inch of either angle.

20. That the direction of these movements may be changed by altering the relative positions of the two bars.

N.B.—For the due conduct of any of these observations it is essential that the degree of energy in the two bars should be as nearly equal as possible, and, if any difference exist, that the moving bar should be the most powerful. The importance of this will be estimated when it is remembered that the needle resting on the end of one bar becomes for the time a point, from which accumulated energy emerges from the bar at rest.

ON THE MOTION OF THE SUSPENDED TEST MAGNETS.

21. That when the very fine magnetic needle points as described above are suspended over the various portions of the magnetic poles they become very sensitive indicators of any motion of force in the bar magnets.

22. That when a quarter inch test magnet is moved over the first inch and a half of the south pole surface nearest the geometrical equator, a double polarity is experienced, the bar magnet attracting the north pole just as usual, but when the test magnet has been laid on the surface of the bar magnet and is raised again, the south pole will leave the bar last.

23. That when delicate one-sixteenth or one-eighth test magnets are held over the surface of a bar magnet they are propelled obliquely toward the edges of the poles, the area over which such repulsion is manifested increasing from each side toward the center, or axis of the poles, as the distance from the equator increases, until a point in the axis of the bar has been reached where the two lines meet, beyond which it is impossible to carry the needle to the pole end without repulsion to one or the other side; the direction of this movement being obliquely upward and outward with a convexity toward the equator.

24. That when the test magnet is carried on one or the other side of this line toward the pole ends it requires to be forcibly dragged through the axis of force, after it has crossed which line it is whirled to the opposite side of the bar.

25. That after passing the crucial line similar movements take place, their direction is obliquely upward and outward as before, but with the convexity toward the pole end.

26. That oval centers of magnetic action are thus formed on each surface of each pole, the center of which is at the point where the test magnet takes a vertical position over the junction of the longitudinal and transverse axes of force.

27. That the above facts are sufficient to prove that the impulses of energy in magnetic force are of a spiral character; and, therefore, that Ampère's theory, which is based upon the existence of closed circuits of voltaic electricity, is found to be incorrect by these experimental observations.

28. That the direction of the energy moving in magnets, and the fact that the principal portion of the force emerges from magnets at right angles to the axis of the bar, prove that the geometrical axis of the bar is at right angles to the principal axis of magnetic force, and, therefore, that the movement of the astatic needle is due to an attempt to bring the current in the needle parallel to the current in the wire.

29. That the facts above enumerated are strictly in accordance with the principles of conservation of energy. Magnetic phenomena being manifested by bodies in proportion as their capacity for force causes reaction to be established at a point of the bar short of the pole end.

DIAMAGNETISM.

30. That in addition to the facts named above, each of which tends to prove the spiral motion of magnetic force, diamagnetism will be found to accord entirely with the spiral movement of the force; and as diamagnetism does not agree with Ampère's law, this is a point of considerable moment.

31. That diamagnetism increases as the power of a body to develop reaction diminishes. This is proved by the experiments of Sir Geo. Airy "in the directive power of magnets;" for he shows that the pole of the steel magnet is distant from the end about one-twelfth of a magnet's length; but the pole of the galvanic coil is absolutely at its end, or, a little beyond the end (*Phil. Trans.*, 1872).

Therefore, as the difference in the situation of the pole is determined by the matter in the core of the coil, it naturally follows that the greater the distance to which the crucial line is removed from the pole end toward the equator, the greater must be the capacity which the bar exhibits for force; and as the converse holds good with regard to diamagnetism, the absence of this line of demarkation between action and reaction, proves that bodies exhibiting such phenomena have very little influence in delaying the transmission of the force or of generating such reaction, and consequently that diamagnetism must increase as the power to develop reaction decreases.

32. That paramagnetic bodies take the axial line in proportion as their capacity for force enables them, under the influence of impressed force, to draw into and transmit through their structures with great rapidity the force that has emanated from all parts of the magnetic poles.

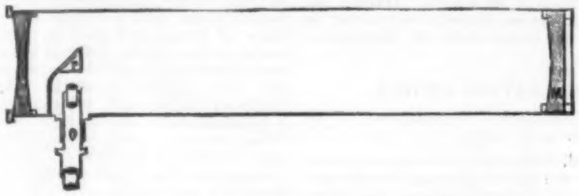
33. That diamagnetic bodies take an equatorial direction in proportion as their low capacity for force causes the largest surface of the body to be exposed to the greatest influence of the force, so as to permit structural saturation being effected with the slightest possible impediment.

34. That the tendency of paramagnetic bodies is consequently to attract the lines of force, as through a funnel, to a central axis, and is typical of magnetic attraction; while the disposition of diamagnetic bodies is to spread the lines of force as through an inverted funnel, and thus is typical of magnetic repulsion.

35. That the movements of the solenoid give proof that a highly diamagnetic body may be converted into a sensitive paramagnetic body, simply by giving a spiral direction to the force which traverses it. While, as far as can be ascertained, every other phenomenon in magnetism, electro-magnetism, or magneto-electricity, can be explained upon the same basis.

M. JANSSEN'S OBSERVATIONS AND OBSERVATORY AT MEUDON.

M. JANSSEN is still working hard at his interesting solar observatory at Meudon. Gradually, but surely, he is perfecting his method of observing the sun by photography. M. Janssen stands alone in his researches in solar photography. For the past ten years he has devoted himself almost entirely to the subject, and his reward has been that he is appointed chief of the observatory at Meudon, where he has at his disposal some of the finest instruments in existence. M. Janssen's last important discovery was, as our readers may remember, the fact that when a picture is taken of the sun with the briefest exposure, there is a vast amount of important detail to be seen. In some portion of the surface the sun appears covered with round granules; in others, these are comet-shaped, or elongated, implying motion. The picture in this instance was secured by an exposure of $\frac{1}{1000}$ of a second, and the result having been satisfactory, M. Janssen now proposes to work only with very brief exposures. New apparatus is being constructed for the purpose, which will permit exposures being regularly made at intervals of two minutes, or for something like $\frac{1}{3000}$ of a second, the pictures of the solar disk, without enlargement, measuring not less than fifty centimeters. This leaves our own observatories at Kew and Greenwich far behind; and if we desire to learn anything of the physical character of the sun, we must in future go to Paris for M. Janssen's results. He still employs his *revolver* apparatus, which he first used at the Transit of Venus operations, and the successive views obtained within two minutes of each other have already given valuable results. In a word, it is found that two images of the sun taken with but a short interval of this character between them differ materially from one another. The phenomena which we have chosen to designate as spots, change, apparently, much more rapidly than is supposed, and within two minutes a couple of pictures of the sun may be secured that by no means resemble each other. Thus we have ample proof that changes are for ever going on in the sun, and there seems little doubt but that M. Janssen will very shortly be able to tell us something more of these changes through his constant watchfulness with the camera. The palace of Meudon, with its park, a lovely suburb of Paris, was, our readers may remember, almost destroyed during the last Franco-German war, and when M. Janssen was permitted to occupy the spot with the instruments that he had carried to Japan and brought back again after they had served to observe the Transit of Venus, the chateau was a mere shell, with scarcely more than the walls standing. M. Janssen's investigations have, however, turned out so well, and appear to be so full of promise, that the French Government has now decided to build him a structure fit for an observatory, with telescopes and cameras furnished with the latest improvements. When he has the benefit of these improvements we may look to the energetic French photo-astronomer for further interesting results of his work.—*Photographic News.*



NEW CATADIOPTRIC TELESCOPE.

NEW CATADIOPTRIC TELESCOPE.

THE question as to the relative superiority of refracting over reflecting telescopes, has often been discussed, but never as yet completely answered. Theoretically, in virtue of their perfect achromatism, it would seem that, in clearness and definition, reflecting telescopes ought to be superior to refracting, the secondary aberration of refrangibility of which it is impossible to overcome in the present state of science. In practice, however, it is otherwise, for, as regards optical power, refractors have always been found superior to reflectors. Messrs. Paul and Prosper Henry have made a great number of experiments in order to ascertain the reason of this inferiority of reflecting telescopes, and, as a result of their researches, find that the lack of clearness, or rather the instability of the images produced by this kind of instruments, is owing almost wholly to currents of air of unequal densities, coming from outside, remaining in the tube, and whirling around therein. In traversing this heterogeneous medium, both the incident and reflected rays are more or less bent, and a confused image reaches the eye of the observer. This had already been suspected as a cause of the trouble, and various means have already been proposed to remedy it. Thus, for example, it has been thought that, by making openings in the lower part of the telescopic tube, there would be produced a more perfect equilibrium of temperature between the exterior air and that inclosed within the tube. The fact is, however, that under such conditions the images have always shown themselves much more confused than before.

Another method, and preferable to the former, consists in suppressing, so to speak, the tube, and leaving only just so much of it as may be necessary to connect the mirror firmly with the eye piece. This arrangement, however, can only be used during very calm weather; for even the very lightest winds cause the image to appear wavy. Refractors have another great defect, which renders them quite inconvenient, and makes their use especially limited. This is the rapid tarnishing of the reflecting surfaces of the mirrors from contact with the air, dampness, dust, etc. From these different causes there results a sensible loss of light, which necessitates a frequent polishing of the reflecting surface. To obviate these various difficulties makers have naturally been led to place the reflecting telescope under the same conditions as the refracting, that is, to close its tube hermetically by a glass lens fashioned in such a manner that it can in no wise injure the optical power of the instrument. Messrs. Paul and Prosper Henry have effected this in the following way:

In the opening of a Newtonian telescope with silvered glass mirror, and of 4 inches diameter and 24 inches focal length, they have placed a crown-glass lens of the same diameter as the mirror and very slightly concave. This form combines several advantages; it prevents the double image which would result from a plane glass, and destroys, moreover, the aberration of the ocular microscope, which in this form of the instrument is formed only of simple lenses. The makers have ascertained by experiment that this modification is absolutely free from any inconvenience. The loss of light which results from the addition of the lens (which may be very thin) is very slight, and as the lens is almost plane, it does not require a perfect centering.

Directed towards the heavens, this instrument has given remarkable results. By its aid, the observer has, in every instance, been able to separate the star σ^2 of Cancer, the two components of which are only 1·5″ apart, while the companion of Rigel is easily visible. The image of a brilliant star has always appeared clearer in this telescope than in another of the same aperture, but mounted in the usual way.

In the figure given herewith, M is a parabolic mirror of silvered glass; P, total reflecting prism, designed to throw the image produced by the mirror into the ocular microscope; O, ocular microscope, composed of four simple lenses; L, double concave lens of crown glass, closing the opening of the telescope.

FORMATION OF THE UNIVERSE.

IN a recent memoir communicated to the Belgian Academy, M. Lagrange offers some novel views on the formation of bodies in the universe. He supposes that before any expenditure of work the quantity of heat of the universe was *nil*, and that the temperature was gradually raised above absolute zero at the expense of work done by attraction. Hence the formation of solid bodies must have preceded that of liquids and gases. Through the gradual condensation of matter, and consequent enormous development of heat, the earth would attain, at least in the parts near the surface, the state of fluidity necessary to explanation of its form and geological characters. As the temperature gradually rose with gradual agglomeration of matter, a very dense atmosphere would form, with pressure diminishing outward, and in a more advanced phase, the temperature of this, after reaching a maximum, would gradually diminish, causing liquefaction or solidification of certain matters at first vaporous, while other solid bodies might remain suspended in the atmosphere. M. Van der Mensbrugghe commends the author's views as original and worthy of the attention of savants, but, with M. Folie, he regards the initial absolute zero as inadmissible. In reply to objections by M. Folie, the author promises shortly to defend this hypothesis: Space is occupied by two substances; one, attractive, which is matter properly so-called, or material atoms; the other, repulsive, which occupies the inter-atomic space, and from which results, between any two atoms, a variable repulsion exercised at the surface of the latter.

PHOTOGRAPHING ON WOOD.

By T. C. HARRIS.*

AMONG the many published formulæ for photographing on wood, nearly all are defective at one vital point; that is, the block becomes wet during the operation. In this respect engravers' boxwood is peculiar, and to wet a block is generally to spoil it. In preparation, the logs are sawn transversely into wheels about one inch thick, and planed down to type height. As the trees are of comparatively small diameters, it is often necessary to glue several pieces together to obtain a block of a given size. To salt and sensitize a block in the usual way wets it, of course, and the final toning and fixing gets it thoroughly soaked. The surface on which the engraver works is endwise the grain of the wood, the pores of the wood running straight through. Water quickly penetrates these pores, thereby causing the block to swell and warp, and, when subsequently dried, very often does not regain its former level condition, which is essential. The small pieces composing the whole often expand unequally, thereby tearing them apart at the joints. Besides this, the glue in the joints becomes softened, making it liable to break in the press. The mere sensitizing of the surface will often cause the block to warp so much that it

* *Practical Photographer.*

is impossible to get good contact in the printing frame. Rinsed negatives are required also, which is another trouble.

There are two ways of printing on wood which give good results, and do not damage the block in the least. From a negative of the subject desired, make a clear, thin positive on glass, by the wet collodion process. The positive should be of the proper size, on clean glass, without substratum. Tone and fix as a transparency, and lay in a dish of water containing a small percentage of sulphuric acid, to loosen the film. The film will soon become so loose that it can be easily stripped from the glass and transferred to the block. To do this safely, lay on the film a piece of wet albumenized paper a little larger than the glass. Press out the bubbles and surplus water carefully, then turn back one corner of the paper, and it will come off, bringing the film with it. Have the block smoothly whitened with Chinese white in gum water, and the surface slightly damp. It is now easy to transfer the film to the wood and remove the paper, when the block must be allowed to dry spontaneously.

Another way to print on wood is by a sort of photo-lithograph process. Coat paper with a thin, uniform coat of gelatine in warm water. Dry, and float a short time on a weak solution of bichromate of potash in water. Dry again, and expose under a negative till all the details are visible. Now roll the entire surface of the print with a printer's roller charged with lithographic transfer ink thinned with spirits of turpentine. Now soak the paper in a dish of tepid or warm water until the ink can be removed by rubbing gently with a soft sponge. All the ink, except the lines composing the picture, can be removed, when the print should be laid face down on the whitened block, and subjected to a heavy pressure in a common letter-press. The paper can be easily removed by wetting the back.

Another application of photography as a help to the engraver was discovered by the writer. Procure hard rubber, in smooth, black, polished sheets of about one-eighth of an inch in thickness. These are to be cut to the proper size, cleaned and albumenized the same as glass for negatives. The rubber plate is covered with collodion, sensitized in the bath, exposed in the camera, and developed in the usual way of making a negative. In fact, the whole operation is exactly the same as in making a ferrotype on rubber instead of an iron plate, and a ferrotype bath and collodion are well adapted to the rubber. When a clean, sharp image is obtained, it is fixed in cyanide and varnished with a thin, transparent varnish, and dried by a gentle heat. The plate is now ready for the engraver, who will have a fine smooth surface and a clean drawing to work on.

When engraved, the plate is mounted on a wood block, and made type high, and is ready for the printer. The rubber is somewhat more difficult to engrave on than box-wood, but the surface is much finer, and makes a more durable printing block. Unless more than one cut is desired, it is unnecessary to have it electrotyped, as wood cuts are, but the original can be used in the press along with type, and as many as seventy-five or one hundred thousand impressions taken from before it shows wear.

THE PHOTOGRAPHY OF VISION.*

By W. S. BIRD.

THE daily and weekly journals occasionally indulge in quasi-scientific romances, and are prone to let imagination loose over photographic marvels.

The latest tale of wonder has been concocted on very slender data in connection with recent researches on the physical structure of the retina, and with the endeavors to fix on that sensitive membrane the images that impinge upon it. The tale goes circumstantially to prove that upon the retina of a murdered person has been distinctly traced the photograph of the murderer and the theater of the crime. Justice has been depicted armed with a new power for the detection of the criminal, and the old adage that "murder will out" has received a marvelous exemplification in the mechanism of the eye itself.

Belief in a story of this kind would not be difficult for many people, and even a photographer knowing how parallel are the optical arrangements of the eye with the appliances of his art would not be unduly credulous to give the matter some consideration. The eye and the ocular orbit indeed form a veritable camera obscura, the dark lining of which, necessary to absorb scattered rays of light, is represented by the pigmented layers of the choroid membrane. The aqueous and vitreous humors answer to the lens, and serve the same optical purpose of collecting the rays of light to a focus and throwing the image of external objects on the retina, which represents a concave sensitive plate. The iris, with its power of contraction and expansion, answers to the diaphragm, and the ciliary muscles, which change the curvature of the anterior surface of the crystalline lens to suit varying distances of the object from the eye, has its analogue in the adjusting screw. The parallel might be carried still further with considerations of optical aberrations in both the vital and the mechanical lenses, and the corresponding corrections by which in both cases the differences are compensated or modified.

Enough has, however, been said to show that it is not exceedingly strange if a ready credence has been given to accounts of images impressed on the living retina with uncommon vividness being found there shortly after a violent death, and becoming a damning witness by the dead victim against the murderer. Fixing the photographic image thrown on a daguerreotype plate was an almost miraculous fact at first, and that nature should be found more wonderful than art is an ordinary experience.

The intention of this paper is to indicate the small substratum of fact upon which imagination evolved its new romance, and to show the continued parallelism between the photographic and visual records of luminous impressions. The most recent researches of physiologists on the function of the retina bring the subject fairly within the limits of photographic interest. For the facts I shall bring before you I am largely indebted to an article in the *Revue de deux Mondes* for March, entitled "Les Colourations de la Rétine et les Photographies dans l'Intérieur de l'Œil."

In the mechanism of vision the retina is the membrane that receives the image of objects and conveys luminous impressions to the brain. A nervous current is believed to be set up by the impingement of the light, and we see, but by what transition a motion of nerve matter becomes a mental consciousness, is a transcendent wonder, as much beyond the physiologist or the philosopher as it is outside our inquiry. But if in vital phenomena there is between means and the end a gulf impassable to our intelligence, yet all inquiry into the material basis of life leads to the conviction that vital manifestations are cognate with states and conditions of the organism, and researches into these conditions can never be a useless quest, although an ultimate mystery is involved that exceeds our power to solve.

The retina is a thin, glossy membrane, the segment of a sphere, concave in front, and situated immediately behind the vitreous lens. Its texture is delicate, and its surface presents a small yellow spot, of which the center corresponds with the anterior posterior axis of the ocular globe. This spot is believed to be the most sensitive portion of the membrane, and among mammals is found only in man and the monkey.

Of old, anatomists saw in the retina only a membrane of two layers or coats, but in our days the microscope has largely augmented knowledge, and now some seven distinct layers are found, in one of which the presence of numerous minute cones and rods has been established beyond doubt by the concurrent testimony of independent observers. The cones are mostly found in the yellow spot, the rods being more plentifully distributed throughout this coat of the membrane.

These rods and cones, composed principally of extensions of the optic nerve, whose terminations form the anterior surface of the retina, have been likened to the papillæ of the skin in which the tactic nerves terminate. The cones are supposed to receive qualitative or color impressions of light, while the rods take measure of intensity. Be this as it may, both cones and rods appear to play an important part in giving definite body to the image received by the retina; that is to say, the consciousness of seeing is not acquired merely by the image of an object falling on the retina, but the momentary fixation of that image takes place by physical changes in these rods and cones. It is this apparent fixing of the image which carries beyond previous experience the analogy of the globe of the eye and the camera.

The retina rests, as we know, immediately on the choroid membrane, which is full of pigment cells, the color in which determines the hue of the external eye, but the substance of the retina, with the exception of the small yellow spot already mentioned, has, until recently, been considered colorless.

The researches, however, of Professor Boll, of Rome, has led him to conclude that the true color of the retina is purple-red, but that this color is discharged by light. This visual purple can only be discerned in obscurity, or under such artificial illumination as will not discharge it. The color does not disappear immediately with life, Professor Boll having preserved extirpated eyes for twenty-four hours, when the color was still visible, and only disappeared on access of light. The cause of the retina having been hitherto found colorless is not, therefore, death, but it is simply the consequence of exposure to light. The retinæ of rabbits and frogs, which had been killed in the dark, showed a bright purple-red color, but if killed in sunlight the retinæ were found colorless.

The existence of visual purple being thus placed beyond doubt, the quest began to discover its nature. Could it be a veritable pigment? or was it only a condition of physical variation in the structure of the organ? Freezing the retina did not destroy the color, and while immersion in alcohol, ether, or chloroform did destroy it, yet these liquids did not receive coloration. The existence of a pigment was doubted, but Kühne (a name well known among microscopic anatomists) succeeded in obtaining a solution of visual purple from which light expunged the color. Kühne employed as solvent fresh bullock's bile, purified and freed from its own color. He further collected the purple in powder, and found that while dry it resisted light, but if damp the light discolored it. Putrefaction in its early stage did not destroy the color. Solutions of the pigment were discolored by solar light in a few seconds; by gaslight, in half an hour. The extreme lines of the spectrum acted feebly, both red and violet; the blue and yellow were more active.

The sum of Kühne's conclusions may be stated thus: All visible light decomposed the retinal purple, but in variable times, the conditions of exposure being similar. Whatever the source of light employed, the visual purple, in losing its color, passed first to yellow, then became white. The flame of sodium was found to be the least active on the pigment, and experiments were conducted by this illumination.

In life the color of the retina renews itself continually, the source of the color believed to be in pigmentary cells of the cones and rods mentioned as part of the structural apparatus of this membrane. The importance of this discovery of Boll and Kühne lies in the fact that here is seen for the first time palpable material modifications corresponding with impressions conveyed to the sensorium.

This is a step forward in the mechanism of a conscious impression. The anatomy of the organs of sense has received the earnest attention of many eminent men, and the structures have been elaborately described, without much insight into the functional method. Take the ear for an example. We are ignorant by what means a wave of sound, impinging on the tympanum, excites the nervous movement which results in hearing. The impression must, judging by all analogy, be conveyed by some material means. If Boll be correct in his theory, he has in the case of vision gone a step further in the discovery of the means, and the results may stimulate research on other organs. The theory is, that the optical image thrown on the retina is momentarily fixed or apprehended by the actual formation of a pigmented picture, in which purple corresponds to the shadows, white to the high lights, and insensible gradations between these extremes to the half tones.

This granted, we obtain wonderful insight into further correspondence between structural and conscious phenomena, and Boll goes so far as to say that the action of different agents—light and color, waves of sound, palatable substances, odors, temperature, etc.—produce in the terminable organs of sensation certain physical changes commensurate with the feelings produced. Such a statement touches in a revolutionary manner some old philosophies, but is in accord with similar tendencies of thought in various fields of research; still, it may be doubted if there be yet such firm foundation of fact as will support so bold an induction.

The existence of visual purple, and its special relation to light acknowledged, the more ardent investigators fancied optography discovered, and concluded that, by supplying conditions which should temporarily fix the image on the retina, incontrovertible evidence might be obtained of the fact.

It was not unreasonable to suppose that a visual image, strongly impressed on the retina, and materialized in actual pigment, would remain there sufficiently long to record its own evidence. If so, such evidence, in cases of violent death by accident or crime, would, indeed, be conclusive, and minister to justice. To solve the problem was difficult, for the vital action which furnished continual supplies of color to the retina, and the decoloring effect of light, were compensatory. To obtain an optograph, it was necessary this compensation should cease.

Various experiments were made. Kühne had satisfied himself that, while the visual purple was not immediately destroyed by death, yet that the power of renewing it was obliterated, and the conclusion followed that, to fix an image on the retina long enough to prove his theory, he must still follow photographic practice, and cap the vital lens immediately after exposure. Not only must he thus secure the sensitive retina from further access of light, but also stay the vital compensating action by destroying the life. But, before arriving at this double conclusion, he experimented with the freshly extirpated eyes of rabbits, fixed these immovably for a few seconds before a brilliantly illuminated object, then shut out the solar light, and examined the retina by the sodium flame.

The results were unsatisfactory, for, although the form and relative site of the object were discernible on the retina, the outlines were too vague and indeterminate to convince the doubtful.

Kühne attributed this partial failure to the opacity both of the cornea and of the retina which death produces. Light would be hindered in its passage through the eye to the retinæ, and that membrane probably lowered in sensitiveness. He, therefore, sought to overcome the obstacle by experimenting on the living animal, which he placed before a square opening cut in a window shutter. The creature's head was first covered with a black cloth to insure full development of the visual purple, then the light was allowed to act for a couple of seconds, and the animal immediately decapitated. One eye, rapidly extirpated by the light of a sodium flame, was plunged into a solution of alum, and the other eye left in its orbit similarly treated. Next morning the two retinæ were detached, and there was distinctly visible in each the square image representing the luminous opening, and more accentuated in the second eye than in the first. Upon exposure to light the image disappeared by the discoloration of the whole retina.

Thus encouraged, Kühne undertook to photograph more complicated objects, and succeeded with rabbits, under the conditions described, in obtaining perfectly distinct impressions of a window; not merely the square opening, but the vertical and horizontal bars were distinctly visible. He succeeded thus far equally with eyes in a recently decapitated head, but the exposure in such case was much longer than when the experiment was conducted with the living animal. The difficulties of such inquiries were, of course, very great, but Kühne believes not merely that optography is an established fact, but that it is possible to obtain landscapes and portraits photographed on the retina, when the conditions can be brought under greater control.

Something must be allowed for the enthusiasm of the discoverer, but the ascertained facts are sufficiently striking to give probability to the theory, and remarkable enough to account for the romantic statements which have had some currency in the newspapers.

The facts are strange, for it is almost inconceivable how any mechanism of the sort can adjust itself to the varying experiences of one minute's vision. The rapidity of the impressions received, their constant succession, the variety of objects far and near discerned in a single glance, are so immense, that it is bewildering to believe that every gradation of light and shade registers itself in the minute structure of a delicate membrane by waves of purple color momentarily modified in harmonious correspondence with the impact of reflected light. The retina becomes the microcosm man has been said to be, and that we are fearfully and wonderfully made may be better realized now than in the old time.

This marvelous adaptation of means to an end is paralleled by the modification of the curvature of the anterior lens of the eye to enable us to focus distance. For sharp definition in the camera either the lens or the sensitive plate must be shifted for different planes of distance, and a similar adjustment is necessary in the eye. From any distance exceeding seventy yards rays of light entering the eye may practically be considered parallel, and no adjustment is required, but between these seventy yards and four inches, which is the average point of proximity to the eye for an object to be clearly seen, there must be adjustment. If we look through the meshes of a net at an object beyond it, both cannot be clearly seen at the same moment. In the interval by which the two objects are discerned, the ciliary muscles act to increase or diminish the curvature of the front surface of the lens.

Conceive the almost instantaneous rapidity with which we discern objects scattered over a distance of fifty yards, and yet at every point of the distance each object distinctly seen was focused on the retina by a distinct change of curvature of the visual lens. One reason why viewing a picture or sculpture gallery is so much more fatiguing to the eye than continual change of landscape, is that in the one case there is perpetual action of the ciliary muscles to accommodate the varying convergence of the rays of light, while in the other, the parallelism of the rays makes no such demands on the organ. It is as wonderful a power of accommodation to optical necessities, and as marvelous in itself, as the color changes in the retina for the performance of its function.

Without venturing to express an individual opinion on the discoveries and theories of Boll and Kühne, but willing to wait for further confirmation, I have thought a statement of these latest novelties in vital optics worthy the attention of the members of this society.

* A communication to the Photographic Society of Great Britain.

METALLIC PLATES FOR PRINTING, ETC.

MICHAUD'S improvement is as follows:

My invention has reference to the well-known photographic process, in which the action of light on bichromated gelatine or on bitumen is made use of for reproducing casts of moulds, sunk or in relief, from photographic negatives or positives, as the case may be, and it consists—firstly: In improvements in the treatment of such gelatinous bichromated plates. And, secondly: In improvements for obtaining therefrom metallic casts or moulds available for different purposes, as hereafter stated.

According to the first part of my invention, when proofs are required from a bichromated plate taken from a negative after nature or a work of art, in order to produce a grain on the said proofs printed therefrom I dust uniformly on a glass plate an opaque powder, and then cover the same with a carbon sheet coated with a colored bichromated gelatine, and expose it to the light, after which exposure it is applied under water to the negative, previously coated with gum containing a trace of chromic salt, and then developed in tepid water, which carries off the gelatine that has not been acted on by light, leaving the insoluble parts thereof forming

the required grain adhering to the negative in the shape of an exceedingly fine pellicle.

When a metallic cast is to be taken from a bichromated gelatinous negative, after the same has been developed in the usual manner, I dry it in the open air, and then place it in a closed case, at the bottom of which I place blotting paper or other similar absorbing substance damped with water, the glass plate being separated from the blotting paper by a few glass rods. After remaining from one to several hours in this box it is extracted therefrom; the gelatine thereby slightly swollen is slightly coated with very fine plumbago by means of a very fine brush, and in this state the plate is ready to be cast from.

According to the second part of my invention I produce a metallic mould or cast from a gelatinous bichromated negative or positive mounted on a metal plate, as the case may be, by the use of alloy of metals fusing at a relatively low temperature, and by means of a slight pressure. For this purpose I make use of 1,100 parts by weight of an alloy known in France as "D'Arcet metal," containing bismuth 1, tin 0·50, and lead 0·50, to which I add 100 parts by weight of mercury. I place this alloy in an open case, wherein it is fused in any appropriate manner, or I pour it previously fused in this case, then lay the bichromated proof thereon, face downwards, applying the same with a slight pressure, such as is readily obtained by a screw, a lever, or any similar agency, and leave it thus until the metal has hardened. The *cliche* is lastly separated therefrom, and the metallic cast or mould thus obtained can then be made use of—in the first place, for taking therefrom proofs in transfer ink for lithographic printing in the ordinary manner; in the second place, for metallic blocks for typographic printing; or, in the third place, for the immediate production of a galvanic mould in relief, from which may be taken at once galvanically any number of sunk moulds for jewelery of any size, or for copperplate printing, neither moulds or casts requiring any retouching.

According to the hardness of the cast required the proportion of the tin or of the lead in the D'Arcet metal may vary from five to twenty per cent. each.

For the purpose of producing signboards, door plates, or other similar plates replacing the usual engraved plates, I also make use of a solution of bitumen instead of gelatine, as above stated, in which case the bitumen is coated on a brass plate, after sufficient exposure to light, in contact with the photographic negative. It is developed in spirits of turpentine, washed in an abundance of water, and then immersed in a galvanic bath, the nature of the metal contained in which will vary according to the requirements. The unsolarized bitumen being then separated from the plate this latter is lastly immersed for a few minutes in a solution of ammoniacal carbonate of copper; or, if it is desired to deepen the inscription in the plate, it must be placed for a few minutes in a solution of salt of copper, slightly acid, before producing the above mentioned reaction by means of the ammoniacal salt.

Having now described and particularly set forth the nature of the said invention and the manner of carrying the same into effect, I would have it understood that I claim as my invention—

Firstly. The method above described of preparing a bichromated gelatinous negative so as to produce a grain on the proofs to be taken therefrom by uniformly dusting on a glass plate an opaque powder, covering the same with a carbon paper coated with a colored bichromated gelatine, and then exposing the same to light, applying the same under water to the negative previously coated with gum containing a trace of chromic salt, and then developing it in tepid water, which carries off the gelatine that has not been acted upon by the light, leaving the insoluble parts thereof forming the required grain in the shape of an exceedingly fine pellicle adhering to the negative to be printed from.

Secondly. The process above described of swelling the gelatine negative previous to casting a mould from the same, by inclosing it for one or more hours in a box containing damp blotting paper or fibrous material saturated with water, the said negative being isolated from the damp material by a few glass rods, and after extracting the swollen negative from the box coating it with finely pulverized plumbago.

Thirdly. The process above described of making metal casts from bichromated gelatine negatives by the use of an alloy of metals fused at a low temperature, such as a mixture of 1,100 parts of D'Arcet metal containing bismuth in the proportion of 1, tin 0·50, and lead 0·50, with 100 parts of mercury, the lead and tin ingredients varying in the proportion of five to twenty per cent., according to the hardness of the cast required as above described.

And, fourthly. The process above described for producing signboards, door plates, or other similar engraved metallic plates, by using bitumen coated on a brass plate exposed to light under a negative, and then developed in spirits of turpentine, washed in an abundance of water, and immersed in a galvanic bath, and after separating the bitumen from the galvanic plate immersing the latter for a few minutes in a solution of ammoniacal carbonate of copper, and, if desired, to deepen the engraving on or in the plate, inserting the same for a few minutes in a solution of salt of copper, slightly acid, before producing the above mentioned reaction by means of the ammoniacal salt.

The special features of the invention are thus seen to consist in—1. A peculiar method of imparting a "grain" to the surface of plates to be engraved in half tone, by attaching a granular pellicle to the photographic negative employed in the formation of the gelatine mould. 2. A modified treatment of the gelatine mould previous to taking the cast from it. 3. A method of taking casts from the gelatine relief in fusible metal and under pressure, by which means the greatest sharpness is obtained. 4. An application of the bitumen method to the production of engraved plates, which, however, does not appear to present any feature of a novel character.

THE SALTPETER CAVES IN VIRGINIA.

By H. HAUPT, Jr., M.D., Ph.D.

WHILE our late civil war was devastating the country in the South, supplies of all kinds became short, and among other things the stock of gunpowder rapidly diminished. The coast being blockaded, niter or saltpeter was a very scarce commodity in the Southern States, and the people of the South were obliged, like their ancestors, to depend upon their internal resources for supplies. A careful search revealed the fact that in Giles County, Virginia, near the town of Newport, there is an earth which contains niter. This earth is ledged in lodes or pockets among the limestones of that region, and upon the surface beneath houses. The extraction of the niter could not, for obvious reasons, be carried on in the broad light of day, so advantage was taken of one of the caves abounding in this region for its manufacture.

Early in the month of August, 1878, an exploring party, consisting of Messrs. W. H. Phillips, A. J. D. Haupt, and the author, left Mountain Lake Hotel, equipped for a two days' camp out, intending to thoroughly explore the Niter Cave on Sinking Creek. Crossing the summit of Bald Knob Mountain, we descended its rugged side by one of the many trails used by the hunters in their search for deer, and reached the Newport and Union turnpike, which we followed to the ford at Sinking Creek. This creek is so named because it sinks into the ground at the foot of a mountain to the southward, where we fetched a compass, and traveled along the Newcastle road for seven hundred yards to an open field, crossed the ford, and proceeded in a northwesterly direction to the mouth of the "Niter Cave," which lies in a deep depression in the earth, resembling the ancient amphitheaters of which we read in pages of history. The sides of this amphitheater are covered with trees and bushes, and upon the rocky cliff in which the entrance is found, the wild grass grows luxuriantly, adding much to the picturesqueness of the scene. So deep is the depression that the tree tops are not visible from the road, and there is nothing about the place to cause suspicion of its real nature.

At the base of a cliff about twenty or thirty feet in height is the mouth of the cave, which at first sight, while approaching it from among the trees and bushes, appears small and insignificant, owing to the accumulation of debris at its mouth; crossing this barrier of rubbish by a foot path we come to the entrance, which is a broadly expanded arch not more than fifteen or twenty feet high, but many feet in width. Following the trail, we descended through this arch at an angle of about 25 degrees, and found ourselves in an enormous cavern, with lofty vaulted roof and rugged sides, the floor of this (vestibule, as we will call it for convenience) slopes to the southward at an angle of ten degrees. In the center of the roof, and at many places along the sides, are large openings, communicating with passages leading to pockets in the rock containing niter earth; on the floor of the vestibule, beneath these openings, are piles of earth which was thrown there, preparatory to being carried to the hoppers, of which more hereafter. From the roof of this cavern in many places the lime water descends in incessant drops, wearing away the hard rock and forming basins, upon the sides of which the carbonate of lime has deposited in irregular shapes, giving to the whole the semblance of a miniature fortress upon the sides of some rocky declivity.

Turning to the left and groping about, we at last found a passage in the floor leading under an enormous over-hanging rock, and as a distinct trail led to this spot, we followed it. Descending through a narrow passage so low that progress in the erect posture was almost impossible, and at such an angle that the footing was by no means secure, we reached a gallery bearing to the westward, the sides of which widened out, and of which the roof was more elevated. This gallery is peculiar, being of a triangular shape; one side is formed by the abrupt termination of the stratum of rocks, formed by a fissure. The upper wall or roof is the bottom of the superimposed stratum. The floor is composed of debris caused by the falling in of the undermined rocks. Following this gallery, the floor of which is nearly level and of easy travel, we reached the laboratory. While passing along the gallery, numerous rounded black masses were observed adhering to the roof, and holding up the lamps to make them out, we discovered that in many cases they were bats, which the heat of the torch dislodged and sent whirling and circling about our heads in a most fantastic manner; some of the protuberances were masses of flint.

The "laboratory" is a high, broad grotto, with numerous cross ridges and rugged sides, giving the appearance of massive drapery. The roof is smooth and washed into hollows in many places, showing the action of water in the formation of the cave. The rock forming it is compact limestone, and contains streaks of a harder and more compact rock containing nodules and bands of flint.

In this chamber, as its name implies, the business of extracting the niter was carried on. The earth from which the niter is obtained is a loose yellow clay, containing small particles of carbonate of lime, and considerable silica or sand. It is found in pockets in the limestone and upon the floor in some of the galleries.

The mining tools consist of a mattock and shovel, with a wheelbarrow of the ordinary pattern. Light is obtained from fat-pine torches.

With these tools the earth is dug and carried to the leaching hoppers. These consist of a rough timber frame, supported by four posts, and an inverted pyramid made of boards. At the apex of the pyramid is a grooved board which serves as a gutter to carry off the lye. In these hoppers the earth is thrown and packed, and water poured on, which percolates through the mass, and taking out all the soluble salts, flows down the grooved board into a rough trough, made by gouging a hollow in a piece of split timber. These troughs are of two sizes, one about three feet long, the other about seven, the width being nearly a foot in both instances. The size of the hopper is four feet six inches square at the base, and three feet deep. When the larger trough is full it is emptied into an iron caldron and the lye evaporated. The *modus operandi* is thus described by a native who worked in the mine, and I give his words: "The dirt has to be well packed (in the hopper), and then pour water on the dirt, and keep on until you think all of the substance is exhausted; and then you must have one hopper of good ashes, burned from good green wood (or a small portion of potash), and after you have dealt with your ashes as you have done with your saltpeter dirt (it takes about one hopper of ashes to about five of the dirt) have a good sized trough to put your saltpeter water in, after having taken it up from your hoppers; then put it in an iron kettle that holds fifty gallons or more, and when it is boiling hot pour lye in; it turns a milky color; pour lye in until it turns a muddy color, and then boil till it begins to get thick, and then pour out into another trough, and let it settle over night, then you will find the saltpeter in the bottom. The salt itself will be formed in crystals something like a six square block, or a piece of honeycomb. It takes about thirty hours after you are ready." This thirty hours means from the time of putting the earth into the hoppers. Repeating this process in a small way upon some earth collected while at the cave, I obtained very beautiful, long, slender, hexagonal prisms with pyramidal summits.

It is evident from this description of the process used, that much of the niter is lost in the manufacture, still the yield is considerable, for the same authority says: "There has been as much as two hundred and eighty pounds of pure saltpeter extracted from the dirt that came from under one house, dug 18 by 20 feet, that is, in certain localities, for instance, when houses are built on clay soil, and have been built a number of years.*" The houses in this region of the country are very primitive, as a rule having no floor but the earth, upon which the logs of which they are built are piled; some houses have a rude floor of boards, loosely put together, under which all manner of rubbish and filth accumulate.

The presence of niter in this earth may be accounted for in several ways. In the case of the dwellings, it no doubt comes from the sewage, which accumulates in great quantity in some regions, owing to the fact that one of the apartments of the dwelling (if it should be possessed of more than one) is devoted to the domestic animals, the horse, pig, etc. This fact is rendered more conclusive from the fact that the amount increases with the age of the habitation. In the caves the only explanation which seems plausible is that offered by a writer in a late report of the Department of Agriculture, where he suggests that it is derived from bat guano, etc. This is probably the case in the present one, as this cave contains a great number of these animals, and in many places indications are found proving the raccoon and other animals to be abundant.

Here and there along the walls of the laboratory are openings and galleries in which the earth is dug; some of the passages leading from this chamber run to other rooms, but as they do not contain indications of niter, were not surveyed. In one of these pockets a unique specimen of a fossil trilobite was found. There are no stalactites in this portion of the cave.

At noon we sat down to lunch, which was rendered all the more romantic and fascinating from our novel dining-room. Our thirst was assuaged by a draught of lime water from the neighboring brook that ran gliding and gurgling by, as if seeking in eager haste the merry sunshine, anxious to quit the damp and somber solitude of its rocky bed.

Dinner over, work was resumed. We traveled on, following the brook; in some places progress was almost impossible, owing to the slant of the path and the smoothness of the rocks over which it led. After proceeding a number of yards we came upon a line of hoppers similar to those found in the laboratory.

Suddenly the brook which had cheered our party with its merry laughter, with a roar and plunge leaped into a deep fissure in the rocks, and was lost to view. The rest of our way lay over slippery banks of clay and shaggy rocks. On the clay it was almost impossible to stand, and many times did we measure our own length upon the slimy earth. In this portion of the cave the rocks abound with fossil remains of the Rhynchonelladæ. Beyond the way became narrow and difficult, and having spent several hours in the bowels of the earth, we concluded to retrace our steps to the light of day, and prepare for the night, e'er it got too dark to see.

Returning to the amphitheater, our blankets and other stores were drawn from their hiding place, and we pitched camp. That indispensable article of camp furniture, the coffee pot, had been omitted from our kit, so in want of something better, a tomato can was used for the purpose; the infusion was strained by means of our dental armature, and we managed to make a satisfactory repast, as a sharp appetite seasoned the viands.

Supper over, we lay in the twilight enjoying our pipes, when the gradual dying out of the fire by the accumulation of carbonic acid gas (choke damp) warned us that the amphitheater would not be a very safe place in which to spend the night, "so camp was struck," and after much time spent in fruitless search we spread our ponchos upon the top of an overhanging cliff, and went to sleep under the starry canopy of a clear summer sky as tranquilly as upon a downy couch in the most sumptuous apartments.

Early next morning, as "Old Sol" was tingeing the eastern horizon with his golden rays and transforming each dew drop into a prism to reflect his gorgeous colors, one of our party startled us by rising up suddenly, and drawing his piece preparatory to firing at a black fox (as he called it) with white stripes along its side, which ran into a thicket at our heads. We thank our stars that Mr. "fox" made his escape good before our friend had time to fire, as this species of "fox" is an unpleasant companion when suddenly molested.

As this region of the country is drained by the cave, we were obliged to descend into the heart of the earth to make our toilet, which was arranged by the side of our friend the brook. By the time we again reached the upper air the sun had just risen far enough to send a slanting ray through the arched entrance into the vestibule, and falling in silver beams upon the darkened rock, with a background of almost perfect blackness, the fantastic shadows cast by the quaking foliage from without, presented a scene that beggars description, and we stood for many minutes admiring the spectacle.

As there were several hours before stage time, we entered another mouth of the cave, and wandered amid scenes of great beauty and grandeur, in grottoes whose walls sparkle and glisten with crystals of "calcite." This cave is much more dangerous of examination, as cliffs and precipices with steep clay banks are met with on every hand. One of our party had a narrow escape in this wise. While we were busy cutting out masses of crystal from the walls, he had wandered up a steep gallery for some superb stalactites at its summit. The trail makes a sudden bend just at the mouth of the gallery to avoid a precipice some thirty or more feet in height. While knocking about at the head of this gallery our friend knocked off his hat, carrying his lamp with it, and losing his footing, he came gliding down the narrow passage in total darkness, over the smooth alabaster floor, at a rate which could hardly be measured. Down he came, and had reached the edge of the cliff over which he was almost plunging into the uncertain abyss, when a friendly stalagmite caught him and suspended him in mid air.

The party below was warned of his situation by his shouts, and hurrying up the steep passage, found him sitting in Egyptian darkness on the edge of the cliff, the picture of despair, with his specimens smashed and his clothes covered with yellow mud, with no hat, and fingers loaded with clay, in his vain endeavor to get a friendly grip on mother earth. He presented such a picture that, notwithstanding his danger was imminent, we could not refrain from a hearty laugh at his expense.

As the description of the cave has no direct connection with our subject, we will leave it for another letter.

Returning to the ford in time for the stage to Mt. Lake, we took our seats beside "Old Bald Knob" (the driver), and reached the hotel a tired and hungry trio.

* These statements are taken from a letter of Mr. G. T. Porterfield.

LIFE IN THE OIL REGIONS OF THE UNITED STATES.

By BOVERTON REDWOOD, F.C.S.

PASSING from the wealth and luxury of New York to the primitive life of the oil regions, one seems to enter a new world. King Oil reigns supreme. The railway track on which we travel is occupied at frequent intervals by long lines of tank cars conveying the precious fluid to the refineries, and passenger traffic being of secondary importance, we are thankful when, after many vexatious delays, we approach our destination, a "mushroom" town in the most recently developed district. Hither have sped numbers of operators from the older fields, together with capitalists, and not a few loafers and hangers-on of both sexes, attracted by the reports of "gushers," or flowing wells, and of the scarcity of "dusters," or dry holes. For miles our noses have been greeted with the peculiar, but not altogether disagreeable, smell of the crude oil, and we have noted that the passengers whom we pick up from time to time are oilier and yet more oily.

Arrived at the depot, as our cousins delight to call the railway station, a scene of the greatest confusion presents itself. The platforms are piled with oil well machinery, huge "bull wheels," coils of rope, drills and pumps, steam engines and boilers, and miles of iron pipe. To make one's way from the railway car is a feat worthy of a member of the Alpine Club. Outside the station is a sea of mud, through which teams of horses are striving to drag their heavy loads, and wildly gesticulating are crowds of men with broad-brimmed hats and huge thigh boots, all apparently differing from each other in size only, so uniformly are they covered from head to foot with a coating of mud and oil. With difficulty recognizing in this disguise our friend, whom we had last seen in the usual garb of an American gentleman, we are led to the "buck-board buggy" which he has kindly provided in honor of the lady who accompanies us, and our horses commence wading up to their girths in the pasty apology for a road.

The machine on which we are mounted, albeit marvelously fragile looking to our English eyes, is strongly built of hickory, and appears admirably adapted to its present purpose. Again and again a wheel will sink into a hidden hole with a shock which the thin elastic spring-board on which our seat is fixed scarcely prevents from precipitating us into the mud, and it would seem as if the struggles of the horses to extricate us must end in tearing the frail carriage to pieces. But although the roads are to-day so bad that our friend is complimented on his courage in attempting to drive, we reach our quarters without mishap. We put up perforce at a private house, for the hotel is literally full to overflowing, many being turned away who would gladly pay a handsome sum for a night's lodging on the bare boards. But a new hotel of wood, like all the rest of the buildings in this aptly named mushroom town, is springing up as if by magic, and unless it should happen to take fire, a by no means uncommon occurrence, will soon be ready for occupation.

After a substantial meal, whereat, as usual, sweet potatoes, flannel rolls, buckwheat cakes, with maple sirup, waffles, and other delicacies peculiar to the United States figure prominently, and without attempting to remove the mud which our short ride has covered us, we turn out for a stroll. Picking our way along the plank sidewalks, which are well raised above the muddy roads, and carefully avoiding the numerous holes which it seems to be nobody's business to mend, we leisurely note the characteristics of the place. Feverish energy prevails, and it is soon apparent that we are watching the victims of an epidemic. Every one is suffering from the oil fever which, in this year of grace, 1879, is not one jot less infectious than in the early days of petroleum.

No conversation but of oil, apparently no thought but of oil, everything (even in this short time our clothing) smells of oil, and everything one touches is oily. Even hunger and thirst seem to be regarded as troublesome weaknesses of the flesh, to be indulged only when the worship of oil permits. With difficulty can men be found for any work but that which is directly conducive to oil getting, so dazzling are the prospects offered to the oil devotee, and thus it is that the roads are unmade, and day by day partake more and more of the character of the muddy bed of a river, until, without surprise, we see a scow or flat boat employed in place of a wagon to transport a boiler to a neighboring well.

Shelter from the weather must be had, and since the material of which the dwellings are universally constructed lends itself readily to a somewhat ornamental style, these wooden houses, partially or wholly painted, form a decidedly pleasant feature in the scene. The wooden house has this further advantage, that, as the town grows and the streets require widening, it can be moved to a more convenient position, and more than once we come across a gang of men with jacks and rollers rearranging a block of houses. It sometimes happens, too, that, as an owner increases in wealth and family, he finds it convenient to bodily raise his house and add a new suite of lofty reception rooms at the bottom.

It does not astonish one to hear that the drainage of the town has not yet been provided for, and that the water supply is not above suspicion, but our attention is triumphantly drawn to the arrangements for lighting the streets, which, though primitive, are decidedly efficacious. Mains are laid from neighboring wells producing more gas than oil, and at frequent intervals along the streets vertical pipes are introduced, and the gas, as it freely issues without burner or stopcock, is ignited. Thus great luminous flames, some two or three feet in length, are produced, brightly lighting the thoroughfares.

These lights remain burning day and night, perhaps because nobody can find time to put them out, or, possibly, from a fear that the arrangements of the underground gas works might be affected by a periodical stoppage of the outflow. Efficient lighting is, in such a place, a matter of great importance, for the new oil town numbers among its inhabitants not a few lawless characters, who, under cover of darkness, might make their presence unpleasantly felt. The forms of government are scarcely matured, but the fear of lynch law is not one of the least powerful deterrents from crime.

Noting with curiosity that many carry not only revolvers but also long rifles, we learn that the latter are for protection against wild beasts in the forests outside the town, where several of the wells are located. Many a lonely vigil is kept by the owner of a well in process of sinking, who fears to have his work undone by the malicious act of an enemy, or who is anxious to note, and perhaps to conceal from others, the first indications of the success of his venture.

Suitably clad by our considerate friend in waterproof boots of Brobdingnagian proportions, we pass through the outskirts of the town and prepare to make ourselves acquainted with the mysteries of drilling and pumping a well. The whole country round, almost as far as the eye can reach, is dotted with the now familiar derricks, and toward one of these on the hill side our guide directs our steps. The derrick or timber framework, from which the ponderous drilling tools are suspended, towers to a height of about sixty feet, and the lower part of it being inclosed by rough boarding, forms a chamber about twenty feet square, and open to the sky through the interstices of the framework. Before entering, we observe the contiguous engine house and the massive timber walking beam, one end of which passes through the side of the derrick.

Inside the derrick we see a square opening, some ten inches in diameter, in the center of the timber flooring, through which passes up and down a stout rope attached to the oscillating end of the walking beam already alluded to. At the other end of the rope, now a thousand feet beneath our feet, are the drilling tools, weighing close upon a ton. Every now and then, when the drill has pulverized the rock to a depth of several feet, the gigantic windlass, technically called the "bull wheel," is set in motion by the engine which actuates the walking beam, and the tools are drawn out of the well, which, it will be gathered, is not a well, in the ordinary acceptation of the term, but simply a narrow boring. Then, after two or three bucketfuls of water have been poured down, the "sand pump," an iron tube with a valve at the lower end, opening inwards, is introduced by means of a smaller windlass, and the particles of rock broken up by the pounding action of the drill, and suspended in the water which has been added, are thus removed. The drilling tools are then again allowed to run down, the bull wheel revolving with such velocity that we are warned to stand clear, for serious and even fatal accidents have occurred from the wheel being torn to pieces by centrifugal force.

An anxious and exciting business is this oil well sinking. Not unfrequently it happens that one of the drilling tools becomes broken or otherwise detached in the hole, or perhaps the rope breaks as the well is on the eve of completion, and the whole of the tools are jammed in the bore. In such case, the aid of the "fishermen" is called in, and has to be well paid for. These so-called fishermen are persons who have acquired reputation for their skill in the recovery of lost tools, an operation demanding all the patience of the most apt disciple of Isaak Walton.

The common plan is to use an apparatus of jointed iron rods (a magnified likeness of the chimney sweep's familiar machine), by means of which a hole is drilled and tapped in some portion of the lost tools, and a firm attachment thus secured. Occasionally it happens that the tools must be cut to pieces in the hole and removed piecemeal, and more rarely it occurs that the fisherman's exertions are labor in vain, and the well has to be abandoned.

In addition to the accidental loss of tools in the well, the unpopular "producer" has perhaps to suffer for the malicious act of some unfriendly workman who, with little fear of detection, may purposely drop a drill or "sinker bar" down the well; and then, if all goes right with the drilling, there is the uncertainty whether oil will after all be struck, or whether the hole may not turn out to be dry.

As the detritus brought up by the sand pump shows that the drill has entered the oil bearing sand rock, the excitement is intense. A few hours will now decide whether the past month's labor has been thrown away. The well up to this time cost perhaps $3,000; the owner, as is often the case, may be a poor man who has obtained his machinery on credit; if the well turns out a very productive one, his fortune may be rapidly made, while if the reverse proves to be the case, he is probably ruined. It may be that success appears certain; unmistakable evidences of a rich flowing well present themselves, and the proprietor is already mentally calculating his profits, when, suddenly, an irresistible rush of gas and oil takes place, some underground high pressure reservoir has been tapped, the massive tools are hurled out of the well like the cork from a popgun, the workmen are killed or maimed, the gas takes fire at the neighboring boiler furnace, and the derrick and engine house are burned to the floor.

Reflecting on the speculative character of the pursuit, we push on to another well which is being pumped, and we watch the green-brown oily fluid as it pours into the wooden vat at each stroke of the pump. The raising of the oil is performed by the same engine and beam which had already sufficed for the drilling, the pump rod being attached where the drilling cable was previously suspended. Beneath the end of the beam is a stout vertical balk of timber, called the Samson post, designed to take the weight of the beam in the event of any accident to the machinery.

At each oscillation the mighty beam approaches within three inches of the top of the post, and in this narrow space the attendant points out to us a bird's nest in which a little bird has already reared a progeny. Not for worlds would that rough and oil stained man have had his feathered friends disturbed.

The pumping of the wells is not continuous, but generally takes place twice a day; there are, however, some wells which require no pumping at all, and are accordingly termed flowing wells, the flow being usually intermittent, and often occurring at regular intervals.

Life in the new oil town is not without its convivial aspects. High teas are much in favor, and if the petroleum producers do not very willingly swerve from their allegiance to the oily monarch, and devote themselves to frivolous topics, their wives make up for their deficiencies, and are very charming hostesses. It is true that there are special difficulties in the way of hospitality where the guests can neither walk across the road, by reason of the mud being so liquid, nor swim across, by reason of its being so thick, but these difficulties only serve to enhance the pleasure with which we gather round our friend's well covered table. Local gossip forms, not unnaturally, a prominent feature of the conversation, and the ladies express their sympathy with poor Jack Sinker and his young wife.

Sinker, it seems, has just finished putting down his third well, the first two having been failures, his funds are exhausted, and to-day it is given out that his last venture has turned out no more fortunately, a statement which Jack's rueful countenance seems to substantiate. But in the morning we are surprised to learn that Mr. Sinker has purchased several lots surrounding his last "failure," and by degrees it leaks out that the reports of non-success were not in accordance with the facts, and evidently originated in a very natural reluctance on the gentleman's part to publish his good fortune until he had secured a further portion of the oil bearing territory on reasonable terms.

Returning homewards, the flaring gas jets disclose to our view a bright red painted high wheeled wagon, which our friend seems strangely anxious to avoid, so abruptly does he turn and lead us a circuitous way. While we are speculating on the cause of our friend's behavior, he tells us that the mysterious vehicle, which thus in the dead of night the single attendant is attempting to drive through the mud, is a torpedo wagon, conveying to the outlying derricks the canisters of nitro-glycerine which are exploded in the wells with a view of tapping contiguous veins of oil. More than once, we learn, a torpedo wagon has suddenly disappeared from the face of the earth during one of its midnight journeys. There may be found some who are conscious that their rest was disturbed by a mighty noise, and a shock as of an earthquake, or it may be that scattered fragments of blackened wood and flesh—whether of man or horse who shall say?—tell the sad tale, but perhaps the explosion has occurred far from a human habitation, and a crater-like hole in the virgin soil, over which the blackened and blasted trees stretch their naked branches, is the sole record of the work which has been wrought.—*Pharmaceutical Journal.*

LIFE IN PERSIA.

CONSUL CHURCHILL, in his report upon the commerce of Ghilan, thinks it may be interesting to those who know little of the idiosyncrasy of the people of the country, and who yet take some interest in it, to learn something concerning the tenure of land in Ghilan, and the condition of the lower classes in this part of Persia. It is the general belief that the inhabitants of Persia are oppressed by their rulers, and kept down in the scale of civilization, to the extent that they may well be styled barbarians, by the more favored nations of Europe, but such is not the case. Public instruction in every town of Persia is strictly attended to, although its aims may not come up to the mark of our notions of education. Almost every child, male or female, in the country is sent to school to learn to read and write, or, at least, to learn to repeat certain favored passages of the Koran; and the natural intelligence of the children is so vastly superior to that of their brethren in Europe, the development of their intellectual faculties at an early age is so astonishing, that small children will hold their own with grown-up persons, and talk on subjects that would make our little folk of the same age stare with wonder. But, owing mainly to the fact that every book in Persian is a manuscript, and consequently inaccessible to the lower classes on account of its high price, and to the consequence of this circumstance—namely, that few books are ever read by the people—the Persians, as a nation, are what they were 500 years ago, what we, perhaps, were before the introduction of the printing press in England. To Guttenburg in Germany, and Caxton in England, is to be ascribed the great progress of civilization in Western Europe, and no country will ever keep pace with the civilizing tendencies of the period that does not possess the means of diffusing light amongst its people by this process.

The Persians, altogether a clever and industrious people, capable of imitating almost everything that is produced in Europe, will talk even to this day of the four elements believed in, in the days of Plato—namely, fire, water, air, and earth, and will not be convinced that all such notions have long since been superseded, and proved to be groundless by scientific discoveries. They still cling to the notion that the sun and all the stars revolve round the earth, which they believe to be motionless. With such antiquated ideas, the Shah and his brilliant suite may visit Europe, not once, but half a dozen times, without receiving any benefit therefrom. Saadi and Nizami, Hafiz and Ferdoussi may be very praiseworthy philosophers and poets, but they give very little insight into the best mode of governing and improving a country. Yet the lower classes are far from being miserable. The peasantry are free to till the soil, which in general belongs to the middle and upper classes, and they get an ample portion of the produce of the land for their pains. The middle and upper classes may have become landed proprietors, either by purchase or by inheritance, but they are alone responsible to government for the revenue. The princes and kahns of the empire are appointed by the Shah, as the satraps of olden days, to govern the out-lying provinces in his name.

In Ghilan, one of the richest and most productive districts of Persia, where, on account of its rich vegetation, almost every plant or tree will grow, the lower classes have no reason to be unhappy. Few of them, it is true, possess land, but the arrangements they make with the landowners are all to their advantage. If they engage to clear a piece of jungle, they divide the produce of the land with the owner of the ground. If mulberry trees are planted, the seedlings are purchased by the landowner, and when after a few years silk is produced, the peasant rears the worms and get a third of the produce for his trouble, one half of the remainder going to the landowner, and the other half to the speculator who furnishes the silkworm eggs. As little supervision can be at all times exercised over the villager, he naturally contrives to secure for himself a good portion of the crop. The advantages the peasant derives from his agricultural vocation are not inconsiderable. He can cut down wood in the jungle—that is, the neglected part of his landowner's estates—and sell it on his own account. His cows and sheep can browse freely on those parts that are not under cultivation; he can make charcoal without let or hindrance; he can produce vegetables around his hut, and reap all the benefits arising therefrom; he can rear poultry and sell it on his own account; and last, but not least of all, he can dispose of the fruit which grows in abundance on the estate without consulting the owner of the land. The principal profits of the latter are his portion of the silk crop, the value of the mulberry leaf when sold, and his share of the rice produced on the estate. He also gets, out of courtesy, the first fruits of the land, brought to him as an offering by his tenants. When the silk crop fails, the burden falls principally on the landowner, who has to pay the land-tax assessed years ago, irrespective of what the land may now produce. The peasantry and speculator, together with the landowner, lose their profits.

The taxes are not farmed out in Persia, as they are in the Ottoman Empire, and the officers employed by Government in collecting the revenue are not, as a rule, exacting. Here and there cases do occur in which complaints are made to the superior authorities, but they do not constitute a system of oppression. As a matter of course, in collecting the maliat (taxes), the collectors contrive to extract from the taxpayers some 10 or 20 per cent. more than they are entitled to, but so long as they do not exceed these limits, everybody feels satisfied. When the tax-gatherer grows rich, he is pounced upon by the governor, who makes him disgorge. In his turn the governor is called upon by the Shah, either to pay large presents on his appointment, or heavy fines for reported malversations. The revenue in Ghilan is collected one-half towards the end of August, by which time the silk-crop, which constitutes the principal produce of the district, is

been brought to maturity; the other half is collected toward the end of the financial year.

In India it has been calculated that the income of the native peasantry is on an average £2 a year. In Ghilan it is no less than £5 to £9. The principal food of the peasantry is rice, of which they produce an abundance, of a very fair quality, and at a very low price. The women are mostly employed in the cultivation of this grain. Meat is cheap, 3d. being paid per pound for mutton, and 1½d. for beef. The clothing of the villager in summer is scanty, consisting in dyed cotton wares and no shoe leather; in winter he wears a home-spun woolen cloth of a very coarse but substantial quality; his wants are few, he is sober, and in most cases industrious. Toward the beginning of winter the natives of Khal-Khal, a mountainous region near Ardabil, in the province of Azerbijan, have from time immemorial been in the habit of quitting their lofty plateau to come down into the plains of Ghilan, to seek employment as well as shelter from the inclemency of the cold season. Their rendezvous is the town of Resht, where they are engaged by contract to till the surrounding country.

Some of them thus found their way to the confines of Mazenderan. In some years 15,000, in others as many as 25,000 individuals are thus employed. In coming down from the mountains they carry all they possess in a bundle, which they suspend at the end of a stick. In the towns they collect in the numerous tekkehs erected by the wealthy portion of the population for the performance of their religious theatricals in the month of Moharrem. There is very little skilled labor to be met with amongst them, the utmost they profess to do is to turn up the soil, to dig trenches, and to saw down trees. Their wages are, on an average, 3d. a day, but they are entitled to rations and other advantages which, in money value, make up an income of 6d. a day. After four or five months' labor on these conditions, they return to their homes, where the snow has melted and the soil is fit for cultivation. Their savings do not amount to much. From 10s. to 20s. is the utmost they can put by, and this is usually invested in the purchase of cotton wares for the use of their wives and children, but they have enjoyed a mild winter compared with their own, whereas at home they would have been exposed to all the miseries attending intense cold, and that without occupation.

The peasant is far superior in courage to the townsman, who, it must be owned, has gained the reputation of pusillanimity. In summer you often see the villagers wrestling among themselves, while in winter they hunt the wild boar with dogs, and no other weapon than a short spear. It is remarkable what little crime there is in this part of Persia; seldom does one hear of murder or robbery. A traveler may go from one end of the province to the other without any danger of being robbed. The doors of a house may remain open all night with impunity. Infanticide is a thing unknown in the country. And these virtues may be attributed to the mildness of the climate, which necessitates little exertion to procure a sufficiency of shelter, food, and covering. A single day's labor is sufficient for all the wants of an individual during a whole week. Mendicity is little known, and, with the exception of cripples and blind, very few mendicants are to be seen in the towns, and their lot does not appear to be a very hard one, as they receive ample charity from the inhabitants.

UNIFORM TIME.

ALMOST all the great inventions and advances of the present age have a common feature; in one way or another, they save time. The canal that cuts an isthmus, the tunnel that bores a mountain, the steamship that crosses the Atlantic in a week, the power-loom that supplants the weaver's treadle, the telegraph that is swifter than thought; and even the electric light, which turns night into day, are chiefly valuable as time-savers. Civilized men recognize the general fact that time is the one thing which he cannot afford to lose, because, although we may be able to count its value in money, its loss is really irreparable. And yet in this country we patiently submit to a system, or rather the want of a system, which inflicts constant annoyance, is fruitful of accident, and under even the most favorable circumstances entails frequent loss of time. We allude to the practice of having a different time of day, as shown by the clock in every city and town of the United States. This were troublesome enough if it were all; but also in many towns or cities of considerable size there are two or three different times kept, of which one or two are known as "railroad time," or, perhaps, as the time of the nearest large city. For instance, in a hotel at Washington the principal clock is set to New York time; the same is true of a hotel in New Haven, and doubtless of other places. There is a great railroad which keeps Philadelphia time at its terminus in New York city. As a rule, the small towns on the line of a railroad substitute its time for their own.

But it is when we attempt to unravel the intricacies of railroad time that we have most reason for astonishment. In a report read before the American Metrological Society, at a meeting on the 28th ult., it was shown that there are no less than 75 different localities of "railroad time" in this country. That is, there are 75 different towns, each of which gives its local time to a line or a part of a line of railroad. Some of these places do not differ from each other by more than the fraction of a minute; but the differences are, of course, utterly irregular, the localities not having been selected on any systematic plan.

Who is there that has traveled much in this country without feeling the annoyance of these discrepant systems of time? Before starting to reach a train by a certain moment, the traveler must always inquire whether the advertised time for the train's starting means the local time or the railroad time. If two or three roads center in a town, each may have different times. Even when an advertisement states that a railroad is run on the time of some particular city, the fact may not help the traveler, who does not know that city's longitude or time difference. This sort of trouble culminates when he wishes to leave a train, make a brief stay at a junction-town, and take passage upon another railroad. Even the comforts of a Pullman car and an obliging conductor will not clear the furrowed brow of such a tourist, as he studies his guide book and adds or subtracts the time differences, with the chances of three to one that he blunders in his reckoning. However, a mistake in time is of less importance happening to a passenger than to a conductor. If the latter sets his watch by some other time than that of the particular road, the chances are in favor of an accident, as our railway annals abundantly prove.

Most people imagine that this condition of affairs cannot be changed without causing much more confusion and trouble, in a different way. They say truly that the country is so broad, and the time differences so great, that uniformity of clocks seems almost out of the question. If we were to adopt Washington time, for instance, all over the country, before a San Franciscan finished his breakfast and started his boy for school, his clock might be pointing to noon. Various schemes have been proposed to surmount difficulties of this sort, but those who have devised them have rarely considered the prejudices that must be encountered.

The American Metrological Society is in the business of fighting against prejudices. The public is always willing to see people do its duty, and will no doubt clap hands in applause if some of the reforms which that society is urging meet with success; but just at present we doubt whether the public fairly understands the society. We question whether one well-informed man out of a hundred knows exactly what the society has been suggesting—for instance, in this matter of uniform time; how simple is a part of the plan now proposed, and how easily it may be put into practice.

The idea is to have the same time in minutes and seconds all over the United States. The hours may, however, differ as they do now. It is obvious that the utmost difference that there can be between any two timepieces, is, so far as minutes and seconds only are concerned, a half an hour. The very utmost change in time that the plan proposes cannot, therefore, exceed 30 minutes in any locality. In many prominent cities the entire change proposed—as for New York—is not more than five minutes. The proposition is to take as a starting point a meridian of longitude passing through the Mississippi Valley, nearly crossing St. Louis, and just six hours' time west of Greenwich. All the clocks in the country—if the first part of the plan were carried out—would be set by the time on that meridian, so far as minutes and seconds are concerned. But in their hour-time they would vary with locality; that is, the hour-hand would point to a different hour, with (about) every thousand miles. Instead of seventy-five different railroad times and an innumerable quantity of local times, there would be only five different clock times in the country, even if we count in Canada, and these would have only hour differences, which could rarely create confusion.

This seems to us not in the least a visionary scheme, but a matter of practical importance. The change of time in many of our large cities would be so small as scarcely to attract notice, and nowhere would it be sufficient to cause trouble. Among some of the more obvious advantages are the removal of a known cause of railway accidents, greater certainty in appointments, convenience in travel, and a general increase of accuracy in timepieces, because everybody would want to have clock or watch set to the same time (except as to hours), and any irregularity would be more promptly detected.

In the partial report of the proceedings at the meeting of the American Metrological Society, here given, the formal resolutions on this subject are presented. It will be seen that they cover somewhat more than the plan as set forth above. If that alone could be carried out, and timekeeping be made uniform as to minutes and seconds in the United States, it would be glory enough for a while at least, for the society to have initiated such a practical reform.—*Science News.*

AMERICAN SWORDFISHERIES.

THE swordfish ranges the whole Atlantic coast, from the West Indies to the Straits of Canso, and, we believe, has been met with even in the Gulf of St. Lawrence. In length they sometimes attain thirteen feet from the point of the sword to the base of the tail, of which length the sword should not exceed one-fourth part, and fish have reached a gross weight of over 650 lb.

The flesh, which is fat, white, and sweet, much resembles that of the halibut, and retails at about the same price when fresh, and every summer a number of schooners fit out from Provincetown, Boston, Gloucester, and Portsmouth to engage in this pursuit of the largest food fish known to the seas of either hemisphere.

The vessels in use are of the same general shape and tonnage as those used in other staple fisheries, but where this fish alone is pursued, a smaller crew suffices, owing to the largeness of the game sought and the method of securing it.

On the end of the bowsprit is affixed a peculiarly shaped affair, in which a man may sit without fear of being shaken off by the motion of the vessel or the force of an unexpected surge, and, affixed by loops to the jibstay, attached to a light but strong manila line, is the "iron," which consists of a long spruce pole ending in an iron spindle, on which is the barb, which is looped to the coil of warp on deck.

When fishing, the barb is affixed, and the harpooner, with sufficient slack rope coiled in his left hand, watches for the fish, which is generally found basking on the surface of the sea, and it is said that they seldom move until the vessel is close upon them, or else move leisurely ahead of or under the vessel's bows.

The iron generally pierces through and through the fish, and the pole, thrown out by its struggles, leaves the barb when drawn heavily by the rush of the fish through the water to act as a "toggle" to keep the line from dragging clear.

The fish is sometimes allowed to run out all the line he will from on deck, but more frequently a "drag," usually a tight strong barrel, is fastened to the line and thrown overboard, and it may be that several fish are thus harpooned in succession and captured out of the same school.

At other times these fish are struck from dories, the end of the coil being fastened to a ring in the end of the dory's bow. On sounding off, as they usually do, the coil runs out until checked by the dory, or the bottom is reached, when it may be that the fish buries itself in the mud, and dies there, to be hauled up a mere inert mass heavily loaded down with mud and marine weeds. More frequently, however, the swordfish starts off at full speed, making rushes of from four to eight hundred yards in length, and then as suddenly stopping, preparatory to another rush in a new direction. At such times the light boat fairly seems to fly, and spins round as if hung upon a pivot when the fish starts in a new direction.

Finally, however, the huge fish wearies itself out, and the vessel, running down alongside, recovers the line from the dory or drag, secures the victim with a running bowline, and, if necessary, the lance is used to extinguish the last faint sparks of life. The head is struck off, the body eviscerated, and either cut into slices and salted down in barrels, or put in the iceroom if intended for the fresh fish trade.

Not often does the huge fish show fight, but the accidents which do occur are usually ascribed by fisherman to accidental collisions in the melee of the death struggle of the wounded animal. Generally these collisions take place directly after the fish is struck and has sounded, taking out line fast in its useless retreat into the depths. Suddenly the line slackens, and the fisherman, if a veteran, looks anxiously about him; for it has not unfrequently happened that the first thing seen has been the terrible blade and bony head of the xiphias, bursting up through the bottom of the dory.

On one occasion, Capt. Cann, of Gen. S. C. Lawrence's steam yacht "Nameless," was watching a dory whose occupant had struck a fish, which had carried down a large quantity of line, and seemed loth to reappear on the surface. The fisherman had stepped upon the central thwart, and was looking around for his capture, when suddenly a shower of splinters flew into the air, the head and shoulders of the xiphias came up above the gunwale of the boat, and the fisherman was shot up into the air and overboard. Both man, fish, and boat were finally recovered, however, although the latter was hardly worth repairing.

In another case, the sword of the fish caught a leg of the stout fishing trowsers of the oarsman, and ripped it from ankle to hip, fortunately without hurting the man; while in other instances it is said that the blade has been driven completely through both sides or a side and bottom of the boat.

The fishermen have many stories of the prowess of this animal, which, it is said, sometimes joins with the "thrasher," a small cetacen, in killing a whale. The xiphias, they say, keeps constantly below its huge but unwieldy antagonist, piercing its mountainous sides and belly with its terrible lance, and forcing it up to the surface, when the thrasher, leaping high in air, and being singularly heavy and compact, throws itself on the body of the whale with a momentum of many tons, until the huge frame fairly quivers with anguish.

The sword itself is a nearly straight, sharp-pointed, double-edged blade of bone, porous and light enough in the center, but covered with a tough brown outer coating, and "steeled"—if the expression be allowable—along the edge with a material almost as hard as glass. This must be secreted quite rapidly and constantly, for a break in edge or point will soon become sharp and effective by a prompt secretion of this singular substance.

But few perfect swords are procured, and many fish are found with broken points and very materially shortened by battle or accident, while the edges frequently show great gaps recently received, or which, by the secretion above spoken of, have been "ground down to a new edge," as it were.

The xiphias uses its weapon as the soldier does the broadsword or saber, using both point and edge, and, when pursuing small fish in a school, delivers a succession of sweeping "cuts in carte and tierce," which shear off tails and heads as cleanly as a metallic blade wielded by a strong arm would do.

Of the fearful effect of his thrusts we have already spoken; but in the British Museum there exists a section of the side of a ship in which is still embedded the trenchant blade of a swordfish, which had completely penetrated both planking and inner sheathing. Whether the creature mistook the vessel for a whale or other enemy, or under what circumstances it made its fatal attack, was never known, as the injury was only discovered in docking the vessel.

On one occasion Captain Cann avers that he saw a xiphias and pursued it in a boat, and, when fast, the fish turned and rushed at them as if intending to "ram" the boat, and was only induced to desist by the action of an old whaleman, who, resting a long lance across the gunwale, transfixed the fish's head just through the pintal bone, above the base of the sword. This is the only instance recorded where a swordfish running at the surface has turned and deliberately attempted to fight his way clear of his foes.

Fish of medium size, as is generally the case, are the most difficult to secure, requiring the greatest amount of line and the longest time to secure. Thus a fish weighing over 600 lb. run out but seventy-five fathoms of the line of the "Nameless," and was killed in twenty-five minutes, while one which turned the scales at 375 lb. needed 180 fathoms of line, and died in forty minutes from the time it was harpooned.

Notwithstanding its size and strength, it sometimes succumbs under very slight wounds, when to these is added the tremendous exertions made in trying to escape. On one occasion Capt. Cann threw his iron into a fish on a rough day, just as it rose on a sea, and pierced him through the dorsal fin, but did not touch the spine. Line was given him freely, he ran out about 140 fathoms and was then secured. At another time a wound in the base of the tail proved rapidly fatal, but this was doubtless owing to an injury to the spinal column.

When struck in the head its death struggles are strikingly erratic. The fish leaps again and again high into the air, strikes terrible but ineffectual blows with its weapon on every side; makes short, swift, but devious rushes, ending in wonderful leaps, and finally yields to fatigue, stupor, and death.

Large numbers are taken around the Isles of Shoals, whence many are secured for the New England market, where they are principally used fresh. When salted they bring from $7 to $9 per barrel, and may be dried or smoked when preferred.

The skin is dark brown, with a shade of blue, and is thick, closely attached to the flesh, and has no visible scales. Doubtless, if taken off and tanned, it would much resemble the traditional pigskin beloved of saddle makers, and might be utilized for various purposes of use and beauty. Inasmuch, however, as it is sold with and at the same price as the flesh, it is hardly likely that the producers will care to seek a more remunerative market than they now possess.

When, like the Norwegians, we manufacture "fish flour" and similar compact and economical preparations, it is not unlikely that the white, firm flesh of this great swordsman of the seas will become of more importance and value in the eyes of our fisherman than at present. Until that time, however, the exigencies and requirements of the fresh fish market will limit the catch and govern the pursuit of what is at once the largest and most wonderful of all the vast variety of food fishes which rendezvous in the limits of Massachusetts Bay.—*Boston Journal of Commerce.*

THE custom of a tribe in New Guinea, where Mr. Goldie, the naturalist, and some associates have spent about eighteen months, has suggested the probable origin of the rumors which have been always current of a race of tailed men in some remote corner of the globe. These natives wear artificial tails of such cunning construction as to entirely mislead a casual observer, and they wear nothing except this caudal ornament, which is a plait of grass fastened round their loins by a fine string so as to hang behind to about half way down their legs. Possibly the missing link that has baffled Darwin has only lately become extinct in New Guinea, and these descendants, ashamed of their degeneracy, keep up the tradition of a noble ancestry by simulating their distinguishing characteristic.